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**FOREIGN
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JPRS Report

Arms Control

Arms Control

JPRS-TAC-93-016

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Aerospace Official on Launch of Three More Overseas Satellites

*OW1507144993 Beijing XINHUA in English
1431 GMT 15 Jul 93*

[Text] Beijing, July 15 (XINHUA)—China will launch three more overseas satellites in 1994 and 1995, according to a spokesman for the China National Aerospace Administration.

At a press conference on the exhibition of pictures and souvenirs of China's international commercial aerospace launching services, titled "The Rising Dragon," to be opened here Friday [16 July], the official said that China will use "Long March" carrier rockets to launch a telecommunications satellite for the Asia-Pacific Satellite Telecommunications Co. Ltd based in Hong Kong in June 1994, the Asiasat 2 communications satellite for the Asia Satellite Telecommunications Co. Ltd. in the first

three months of 1995, and the 4.8-ton Intelsat 7a telecommunications satellite for the International Telecommunications Satellite Organization in October 1995.

Since 1985, when the Chinese Government announced that it was bidding for satellite launches, China has established business relations with over 100 firms, research institutes and international organizations based in 36 countries and regions. It has successfully launched the Asiasat 1 communications satellite for the Asia Satellite Telecommunications Co. Ltd., two scientific experimental satellites for Pakistan and Sweden, and two telecommunications satellites for Australia.

However, the official pointed out, China is still weak in the international market for satellite launches. In the three years from 1993 to 1995 a total of 55 international satellites will be launched, but China has only won three contracts.

JAPAN

Support for Indefinite Extension of NPT Unveiled

Foreign Minister Muto on Issue

OW2807093393 Tokyo KYODO in English
0900 GMT 28 Jul 93

[By Masanori Kikuta]

[Text] Singapore, July 28 KYODO—Japan on Wednesday [28 July] gave the first clear indication of its readiness to support an indefinite extension of the Nuclear Non-Proliferation Treaty (NPT) beyond its expiry in 1995, inviting a quick welcome from the United States.

"Because of the general election that we had recently, there remain some procedural matters to be taken care of," Foreign Minister Kabun Muto said of Japan's final decision on the issue.

"However, we should continue to make efforts to move in the direction of an indefinite extension of the treaty."

Muto made the remarks at a joint news conference with his colleagues of other dialogue partners of the Association of Southeast Asian Nations (ASEAN) at the end of an annual regional ministerial meeting.

"I think it is a very positive step forward in terms of the extension of the treaty," said Winston Lord, U.S. assistant secretary of state for East Asian and Pacific affairs.

"We were pleased to hear his comments," Lord told reporters afterward.

Japan stopped short of showing clear-cut support for an indefinite extension during the Tokyo summit of seven major economic powers earlier this month.

Coupled with its controversial two-month shipment of plutonium from France that ended last January, the indecision has aroused international suspicion about Japan's policy of not possessing, producing or allowing nuclear arms into its territory.

Muto said that during a closed session of the meeting he went beyond what he had said about the NPT issue in his opening address. He explained that he feared the world

might misunderstand Japan's position on the nuclear unless he expressed a "more forthcoming stance."

In the address, he only said that for the purpose of strengthening the NPT, it is "necessary to secure universal adherence to the treaty" and lead an expected international conference on its extension in 1995 to a success.

At the news conference, Muto said Japan "wishes to appeal strongly for a significant reduction in nuclear weapons around the world."

The NPT conference will decide whether to extend the treaty for a certain period or indefinitely.

As of last February, 157 countries signed the treaty, which took effect in 1970.

Among countries yet to do so are India, Pakistan and Israel, which are believed to be capable of producing nuclear arms.

North Korea declared in March that it is withdrawing from the pact, rejecting inspections by the International Atomic Energy Agency (IAEA) at two suspected nuclear sites. But after high-level talks with the United States, North Korea announced last month that it is suspending its decision to withdraw from the NPT.

The treaty bars signatories from producing nuclear arms or obtaining them from nuclear powers, and it requires nonnuclear countries to undergo inspection by the IAEA.

Further Report

OW2807064793 Tokyo KYODO in English
0630 GMT 28 Jul 93

[Text] Singapore, July 28 KYODO—Japan will support indefinite extension of the Nuclear Non-Proliferation Treaty (NPT) beyond 1995, Foreign Minister Kabun Muto said here Wednesday [28 July].

Muto made the remark in a press conference after the annual ministerial meeting of members of the Association of Southeast Asian Nations (ASEAN) and their major trading partners.

Japan has so far remained ambiguous over whether to back indefinite extension of the pact, pointing to slow nuclear disarmament efforts among the world's five nuclear powers and North Korea's suspected nuclear development.

HUNGARY

Security Expert Views Ukraine's Nuclear Position

AU1907114093 Budapest NEPSZAVA in Hungarian
16 Jul 93 p 3

[Interview with Imre Fulop, member of the Defense Ministry's Strategic and Defense Research Institute, by Attila Lenart; place and date not given: "Do We Need To Be Afraid of the Ukrainian Nuclear Arms?"]

[Text] Since the dissolution of the Soviet Union and the end of the bi-polar world system, the uncontrollable spread of nuclear arms, rather than a total war, is the worst nightmare of the western leaders. Kiev is reluctant to give up its status of a nuclear power and a number of unconfirmed rumors have been raised on unofficial nuclear arms sales. These kinds of deals can also destabilize the East-Central European region whose security, according to some western experts, is at least as dependent on Kiev as on NATO or on Moscow. We interviewed Imre Fulop on this issue.

Lenart: Does the agreement on arms limitation and nuclear non-proliferation that was made with the Soviet Union also apply to the successor states, including Ukraine?

Fulop: Yes. In 1992 in Lisbon, the successor states agreed with the United States on the validity of the agreements on the limitation of the nuclear arms and armament systems and on the prevention of their proliferation. Ukraine also accepted joining the nuclear non-proliferation treaty as a country that does not possess nuclear arms, and in a letter to the U.S. president it undertook to remove all nuclear arms from its territory within seven years. The agreement states that Russia is the legal successor of the Soviet Union's nuclear arsenal.

Lenart: Who controls these weapons at the moment?

Fulop: Formally, it is the chief commander of the military forces of the Commonwealth of Independent States [CIS], which is the alliance of the former Soviet Union's member states. However, the commanding system is Russian and, therefore, it is under Yeltsin's control. The leaders of the member states also have some power over the nuclear weapons. They cannot launch missiles and cannot effectively prevent this, either, because they only have a right of veto. To quote [Ukrainian President] Kravchuk: His role is to achieve that missiles are not launched, if possible.

The direct control is under dispute: The personnel of the bases belongs to the nuclear forces of the CIS (Russia), but it is formally under Ukrainian supervision. Russia is actually worried about the technical control.

Lenart: According to certain sources, Ukraine is willing to sell nuclear arms. Can this affect our region?

Fulop: It is very unlikely that Kiev would risk any nuclear arms deals. The nuclear arms do not actually

belong to it, therefore, it cannot sell them. This cannot be done officially, and the mafia has not yet reached this far. In theory, in the long run, this possibility cannot be excluded, but the International Atomic Energy Agency [IAEA] and the United States are both watching this very carefully. Nuclear basic materials or some "disappeared" warheads might appear in black market deals, but it is unlikely that these will find buyers in eastern Central Europe. These fears show the ever increasing concern of the West.

Lenart: How well founded is this concern?

Fulop: At the announcement of its independence, Ukraine declared that it did not wish to remain a major nuclear power, however, the nuclear striking power and its disarmament is a very good tool of blackmail, with the goal of alleviating economic problems. Their basic point is that if the United States finances Moscow in order that it liquidates its nuclear arms then Ukraine could also be paid for the same thing. They find the \$174 million that has been offered to them too little and they would like to have nearly \$2.8 billion.

The biggest problem was put across by Ukrainian experts when they said that if the United Nations and the whole world had not been pressurizing Kiev for nuclear disarmament then it would have been completed a long time ago. However, a young and proud republic cannot easily bow to intellectual arguments. In addition, the weapons have but a small security policy role although Kiev often refers to a possible restoration by Russia and to renewing dreams of the empire. The nuclear force only fuels a false illusion of security. Therefore, rather than guarantees, it is, as much as possible, money that is needed just now.

CZECHOSLOVAKIA

Slovak Ministry Statement Says Republic To Adhere to Arms Treaties

AU2107144693 Bratislava HOSPODARSKE NOVINY
in Slovak 20 Jul 93 p 3

[TA SR report: "Weapons Only According to the Agreements"]

[Text] Bratislava—The Slovak Republic will adhere strictly to all the conclusions of the Vienna agreements and the Treaty on Conventional Forces in Europe, which set ceilings on the numbers of individual types of weapons. These are: 478 tanks, 683 armored combat vehicles, 383 artillery systems, 115 combat aircraft, and 25 combat helicopters. This statement was made by the Slovak Defense Ministry in connection with certain reports carried by the press about the alleged purchase of weapons from Russia worth \$180 million as a reciprocal measure respecting Hungary, which wants to purchase weapons and spare parts worth \$300 million from this country.

According to the statement, following the breakup of the CSFR and the division of the Federal Army's property, we have more military hardware than stipulated by the treaties and we have to reduce it gradually before 1995. The treaties do not prevent any country from replacing older weapons with newer and more modern ones. However, the Slovak Republic still has outstanding claims from the past against the Russian Federation, which is willing to pay back this debt in the form of military goods. We have an advance promise of five MiG-29 fighter aircraft along with the necessary spare parts.

BOSNIA-HERZEGOVINA

'Chetniks' Fire 30 'Chemical' Projectiles at Sarajevo

AU2707195093

[Editorial Report] Sarajevo Radio Bosnia-Herzegovina Network in Serbo-Croatian at 1700 GMT on 27 July carries in its regular 24-minute newscast several reports on continued fighting in the republic.

In his report from Brcko, Hamiz Deronjic says that "this afternoon brought ferocious shelling of the defense positions with howitzers, tanks, recoilless guns, mortars of all calibers, Praga, and Bofors. The aggressor's artillery has been particularly fiercely pounding the central part of the Brcko defense. The massing of manpower and equipment along the entire front line indicates that the enemy is preparing to launch even heavier armored-mechanized and infantry attacks."

The Seven South operative Group Press Center reports that "throughout the day the Serbian aggressor used his artillery and Bofors to annihilate Maglaj, while one of the strongest attacks has been registered at 1430 [1230 GMT] against civilian targets in the area. All the defense lines are very stable and that only leaves the aggressor to kill civilians in a cowardly way from (?Todorovici) and Rujnica. As for the positions of the Doboj defenders and the 110 Usora Brigade of the Croatian Defense Council

[HVO], they have been shelled by the aggressor's mortars, and occasionally antiaircraft guns and machine guns, while new grouping and digging in of the aggressor's forces has been registered. The Chetniks have set the Muslim villages of Lepe and Durme on fire in the region of Cevarlija."

Reporting from Olovo, Velid Djindo says that "throughout the day the enemy howitzers and mortars of all calibers have been destroying the remaining buildings in the town. The defense lines are firm and impenetrable thanks to the high moral of the fighters of the First Olovo Hill Brigade, the 126 Brigade, the Sokolac Communal Headquarters, and the HVO Matija Divkovic Brigade."

The Gradacac Information Center reports that "at 1500 an enemy tank and hill cannons shelled the center of the town. The roads leading to the town have particularly been targeted."

Salih Brkic reports from Tuzla that "only sporadic enemy small arms fire could be heard on the fronts today."

In his report from Gorazde, Enes Musovic says that "this morning the Chetniks fired some 10 (?75-mm) mortars at the outskirts of the town." He says that "the Chetniks have attempted several infantry breakthroughs on the line toward (?Orakovci), but they were all repelled." According to him, the citizens of Gorazde "are only surviving thanks to the airdrop operation, which was resumed last night after a two-day pause."

Describing the situation in Sarajevo, the Bosnia-Herzegovina Army First Corps reports that "the enemy artillery attacks on the defense lines of Zuc are still under way. On the rare occasions when the fierce fire from howitzers and mortars dies down, heavy infantry clashes take place. The Serbian-Montenegrin forces have launched several infantry attacks so far, but they have been repelled when the defenders opened heavy fire on them. Infantry clashes of the most ferocious kind are still under way on Golo Brdo." The report says that "the Chetniks have, like never before on the Sarajevo front, used the tear gas [nadrazljivac] chemical agent. Just since this morning up till now, they have fired 30 projectiles with chemical fillings on the area of Zuc. This is the amount they normally fire in a month."

INDIA

Government Urged To Allow Inspection of Nuclear Facilities

93AS0864D Calcutta THE TELEGRAPH in English
8 May 93 p 6

[Editorial: "Talking Nuclear Sense"]

[Text] It has been painful to watch the execution of Indian foreign policy in the past few years. New Delhi has been like a toddler learning to walk, without balance, lacking direction and with a propensity for unnecessarily blundering into objects. It is a source of relief to hear the government is preparing for its upcoming talks with the United States on nuclear non-proliferation by putting together a committee chaired by the cabinet secretary and five ministry secretaries. However there is reason for scepticism. It is bureaucrats of this nature who are largely responsible for India's floundering in the post-Cold War world. It is telling it is only now an apex body has been asked to work out India's negotiating stance on non-proliferation. There remains a fear the committee will do nothing but evolve new stalling tactics or regurgitate the hackneyed words "sovereignty" and "discrimination" once again.

The danger in such geriatric thinking will be the possible reaction of Washington. The U.S. can react in two ways. One, it may weary of oriental obfuscation, and wash its hands of south Asia. This would strike a chord with the isolationist sentiments of Mr. Bill Clinton. While a U.S. pullout was desirable during the Cold War that is not the case any more. Today it would mean India's exile to the global periphery and a further loss of clout in international economic circles. Two, a failure by the state department to make any headway with India would lead to an increase in congressional influence. Senatorial opinions regarding the nuclear non-proliferation treaty are hawkish to the extreme. Unversed in the subtleties of diplomacy or damage to long-term bilateral relations, Congress will prefer bludgeoning to persuasion. India is sure to remain unbowed. But it does not mean it will not be bloodied. It is a price that can be avoided.

New Delhi needs to take the initiative in the talks and explain how south Asia can be made nuclear safe. It is an error to believe the U.S. is adamant about the NPT [Nonproliferation Treaty]. More pressure has been exerted to make India sign on the dotted line by countries like Japan and Germany. Washington has been more blase. There is a reason. The U.S. has recently had unpleasanties with Iraq and North Korea over their nuclear programmes. Both errant nations are NPT signatories. The U.S. realizes the treaty is so toothless as to have little security relevance. The U.S. wants something more concrete. Indications are it will want India to open

its nuclear facilities to inspection, international or otherwise. This will cause coronaries among many Indians steeped in the touch me not nationalism of 1947. They should reconsider. The nation state is more porous these days. The true yardstick should be whether inspection will compromise Indian security. If the cards are played right India's security will be enhanced.

New Delhi's goal should be to allow inspection on terms most favourable to India. This would mean encompassing Pakistan in such an agreement and seeing to it India can opt out of the agreement and pursue a military option if circumstances demand it. Such concessions will require a large reservoir of credibility and goodwill. There are two easy means to score points with the U.S. One is for India to voluntarily stop producing fissionable material as Pakistan did in the Eighties. Another is to take the lead in proposing something that would appeal to both U.S. politicians and public, namely a comprehensive test ban. This would be a Nehruvian grand gesture but one in conformity with the realities of today's world. It is time India's foreign policy establishment showed a greater grasp of the new world order. It is time New Delhi showed greater confidence in its ability to cope with the outside world. There would be no better way to start than for New Delhi to remove the NPT thorn from its side, push south Asia away from the brink of a nuclear arms race and secure membership in the inside circle of the nuclear club.

INSAT-2B Satellite Put Near Geostationary Orbit

BK2507131793 Delhi All India Radio Network
in English 1230 GMT 25 Jul 93

[Text] Indian space scientists at the Master Control Facility [MCF] in Hassan in Karnataka today carried out successfully the second firing of the liquid apogee motor aboard India's multipurpose satellite INSAT-2B. The satellite is in the intermediate transfer orbit for the last two days. The second firing, which lasted for nearly 25 minutes, put the satellite near the geostationary orbit. The spacecraft will now remain within radio visibility of MCF, Hassan, continuously.

U.S. Blamed for Misusing Missile Technology Control Regime

BK2607101593 Delhi PATRIOT in English
19 Jul 93 p 4

[Editorial: "Of Cryogenic Fiasco"]

[Text] So ISRO [Indian Space Research Organization] chairman Prof. U.R. Rao and our External Affairs Ministry were equally ill-informed, or naive, about America's intentions towards India. Prof. Rao's statement at the end of his week-long talks in Moscow was as misleading as had been the Indian External Affairs Ministry's estimate of the strength of U.S. disapproval of Pakistan's terrorist attacks on India. Prof. Rao should have known better. When a person of his authority in

India's Science and Technology [S and T] establishment makes an affirmative public statement, after his prolonged talks with the Russians and the Tokyo pow-wow of the Presidents Bill Clinton and Boris Yeltsin, his compatriots were bound to trust his conclusion. He had said that there was no danger to the Russian commitment to sell cryogenic engines and technology. Our S and T establishment, including those engaged in defence-related research, shows signs of cracking up under the twin impact of U.S. pressure and confused thinking in India's political leadership. Key officials of the defence research organisation and the External Affairs Ministry are allowed by the government to be hired by U.S. agencies (institutions). There is a queue of senior Indian scientists in India's sensitive research agencies cadging jobs in America. It would be surprising if the altered priorities in the people who run India's S and T establishment do not colour their judgement. As for the U.S., there is no reason—unless big powers still have respect for national autonomy—why it should not take the fullest advantage of the chaos in Russia and the greed of India's decision-taking elite. It is immoral of America to misuse the MTCR [Missile Technology Control Regime] to ban technologies to which this embargo is not applicable. The MTCR restriction is to be employed against export of equipment and technology that can be used to produce a missile capable of carrying a nuclear warhead. The cryogenic engine technology cannot be employed to produce such a missile. Neither India nor Russia is a member of the MTCR club. In 1992, America imposed a two-year ban on U.S. trade with Russia's space agency, Glavkosmos, India's ISRO. America thus has acquired extra-territorial powers to decide the nature of trade to be permitted between non-cocom countries. This is a new situation. America's perception would determine trade relations between any two countries, and the domestic U.S. laws would be applicable to countries which have not surrendered their sovereignty to the U.S.. The sanctions being employed against the countries which devise trade relations in their national interests—if these do not obtain U.S. approval—are more stringent than in the past. The U.S. State Department spokesman has dismissed with insensitivity the possibility that the U.S. decision would hurt Indo-U.S. relations. The American official was convinced that there would be no such thing if America were to decide to give India some hand-me-down engines from the U.S. shelves. Today's U.S. officials may not know this, but a similar insensitivity shown by the West in the 1950s, when India wanted to expand basic industries soured India's relations with the Western industrial democracies. Then, as now, the U.S.-led Western powers underestimated India's determination to pursue, for economic and technological development, the path of its own choice.

Kazakhstan Offers New Delhi Use of Baykonur Cosmodrome

*BK2007130893 Delhi All India Radio Network
in English 1230 GMT 20 Jul 93*

[Text] Kazakhstan has offered India the use of its Baykonur Cosmodrome for launching satellites and rockets on a regular basis. The offer was extended by the visiting deputy prime minister of Kazakhstan, Mr. G.A. Abilsiitov, in New Delhi today while addressing a meeting organized by the Confederation of Indian Industries.

PSLV Launch Planned Within One to Two Months

*BK2707161393 Delhi All India Radio Network
in English 1530 GMT 27 Jul 93*

[Text] The Indian Space Research Organization [ISRO] will launch the Polar Satellite Launch Vehicle—PSLV—from Sriharikota in Andhra Pradesh in a month or two. The ISRO chairman, Professor U.R. Rao, said in Bangalore that the PSLV represents India's attempt to acquire indigenous capability in launch vehicles.

ISRAEL

Government Guarantee To Fund 'Amos Satellite Project

*TA1807191493 Jerusalem Israel Television Network
in Hebrew 1830 GMT 18 Jul 93*

[Text] The finance minister has decided to provide \$100 million government guarantee to fund the 'Amos satellite project. Our economic affairs correspondent 'Oded Shahrar notes that the government action is aimed at helping the Israel Aircraft Industries enter the civilian communications satellite market. The cost of the entire project is \$190 million, of which European investors will provide \$77 million.

PAKISTAN

Spokesman Reaffirms Readiness To Sign Nuclear Test Ban Pact

*BK2807114693 Islamabad Radio Pakistan Network
in English 1100 GMT 28 Jul 93*

[Text] Pakistan has again expressed its readiness to conclude a regional nuclear test ban agreement in anticipation of a global test ban treaty. A Foreign Office spokesman said in Islamabad this afternoon that this proposal was conveyed to New Delhi as far back as June 1987 by the then Pakistani prime minister and was reiterated very recently. He, however, regretted that India has continued to respond negatively to this Pakistani proposal.

GENERAL

Status, Future of Nuclear Science Discussed

PM2707132593 Moscow ROSSIYSKAYA GAZETA
in Russian 27 Jul 93 First Edition p 5

[Account by "Nekos" Studio journalists Vladimir Gubarev and Igor Mosin of roundtable conference held at ROSSIYSKAYA GAZETA's editorial offices, chaired by Chief Editor Valentin Logunov, and attended by Russian people's deputies and nuclear scientists from Arzamas-16 and Chelyabinsk-70; date not given; carried under the "Science and Safety" rubric: "The Future of Nuclear Centers"]

[Text] Russian people's deputies and creators [sozdatel] of nuclear and thermonuclear weapons from Russia's two federal centers of Arzamas-16 and Chelyabinsk-70 met at a roundtable conference in ROSSIYSKAYA GAZETA's editorial offices.

The meeting was chaired by ROSSIYSKAYA GAZETA's Chief Editor Valentin Logunov.

The situation prevailing in Russia's nuclear complex is such that it is no longer possible to keep silent; it would actually be criminal to do so: After all, the country's safety is at stake. Russia has two supersecret cities—Arzamas-16 and Chelyabinsk-70—where atomic weapons are being created [sozdatsya]. Thousands of talented people ended up behind the barbed wire fences, devoted their lives to the fatherland's security, and worked unsparingly, being perfectly well aware that the country needed their labor. Now, however, these people have been abandoned to the mercy of fate....

ROSSIYSKAYA GAZETA has already written about the prestrike conditions proclaimed in these cities and the rallies held there. All these events must alert the public, because the issue concerns the future of Russia, its defense capability, and, ultimately, the safety of the weapons themselves.

Vladimir Belugin, Director of Arzamas-16 Federal Nuclear Center:

Our center employs 2,500 scientific associates holding top qualifications and about 10,000 engineers and specialists. It also employs about the same number of workers. The institute [not further identified] has several academicians, 60 doctors of sciences, and about 700 candidates of sciences on its staff. This is one of the world's mightiest and largest institutes. But we have started withering over the last few years. Boris Yeltsin visited us in February 1992. The president dispelled the doubts of Arzamas-16 and Chelyabinsk-70 associates. He declared that Russia would not forget us and would support us, seeing that it needs us. Serious decisions were adopted at that time, laying down guidelines for research and development, the pay of specialists, and the maintenance and development of

the social base. Unfortunately, however, these decisions have been—to put it mildly—quietly backbursed ever since the middle of last year. Now both federal centers are in a catastrophic state.

It appears that we are in debt to all and sundry. Not because we are working badly. It is simply the fault of the tax system, of abnormal financing. For some reason people think that we are doing quite well, living in prosperity. I have before me a rather interesting document. It lists the average wages in our city. Nuclear industry workers rank 21st in this list. Our average wage is 36,000 [rubles], whereas sobering-up station staff earn 72,000....

We have developed our work programs. Our basic aims and tasks focus on the problems of nuclear weapons safety. They are extremely topical. Furthermore, an extensive package of conversion programs has been developed, comprising 18 of them in all. They concern major avenues in the power engineering industry, machine building, medicine, ecology, and so on. The programs have undergone comprehensive feasibility studies, but they have not been approved to this day. Generally speaking, much has been said but nothing has been done.

Unidentified questioner: For how long will Russia's federal centers survive if the situation does not change?

Belugin: The specialists are leaving us. Some 660 people in the last three months. Furthermore, these people are mainly under the age of 40. They are going to commercial structures. You cannot blame these people, they have children to feed. In addition, wages are regularly paid there, whereas ours are constantly two-three months in arrears. If this continues, Russia's both nuclear centers will be ruined within a year.

Radiy Ilkayev, First Deputy Scientific Leader at Arzamas-16:

I would like to add a few words about economics. Imagine the following situation: A scientific associate is conducting research for the country's defense. He receives some sort of wage. At the same time, the state employs someone to watch over him and ensure that secrets are not leaked. Nowadays a scientific associate earns a fraction of what is earned by the person watching over him. An absurd situation, is it not?

Of course, in our capacity as leaders of nuclear centers, we are responsible for the creation [sozdaniye] of weapons, for their safety, and for ensuring that nuclear technologies do not proliferate all over the planet. But it is simply impossible to keep an eye on hundreds of people under the age of 40 when they resign, leave, and join other structures. A very serious problem arises as regards the nonproliferation of nuclear weapons. It seems to me that we are underestimating the prevailing situation. Talk about nonproliferation is becoming more of a utopia.

A few words about the situation in the Arzamas-16 and Chelyabinsk-70 scientific centers. They have employed virtually all the famous scientists who were in one way or another associated with nuclear physics. They laid the foundations of a fundamentally new scientific school. This school is unique in both scientific and social terms because never before, not even during the harshest of times, has there been such freedom and boldness of statements on all political questions. And no matter how strange it may seem, the country's leadership treated all this calmly, because the main demand made of us was to create [sozdaniye] specific nuclear systems [yadernyy zaryad] and nuclear munitions [yadernyy boyepripas] on par with the Americans. And this is what happened, beginning with the hydrogen bomb. But unilateral moratoriums came into being and we failed to perform the task set in the last few years—to sharply boost the safety of our weapons. This safety is necessary not to enhance the weapons' combat specifications but primarily to ensure reliability in use, transportation, and maintenance, in other words to ensure safety in our daily life. But, let me repeat, due to the unilateral moratoriums which became the object of political games, we are lagging behind the Americans in this sphere.

Now about another avenue of work. It is impossible for a nuclear center in any country to function without fundamental and applied physics research, usually involving work at world standards. Otherwise the federal center will turn into an ordinary office, unable to tackle the most advanced technologies and the most advanced designs. We have always been concerned about ensuring that our scientific section is maintained in a proper state. It is really, really important in both federal centers. We have the world's largest nuclear reactors, excellent laser installations and test facilities—generally speaking a solid technical base. If it is undermined—and this is unfortunately happening—sometime in the future it will become simply impossible to maintain modern nuclear weapons to a sufficiently high standard.

Stanislav Voronin, Chief Designer of Nuclear and Thermonuclear Weapons:

I believe that the nuclear centers are a national asset. They were created over a period of decades by the entire country and the entire people. If they were to be destroyed today, it is easy to imagine how much effort would be required to recreate them. In my view, it would be a crime to allow their disintegration.

Our misfortunes began when the country embarked upon market economics. The point is that we have no output which could be marketed. In this sphere of work, unless firm budget financing is available, we will be totally unable to ensure the development of nuclear science to provide the basis for producing nuclear weapons.

The development [razrabotka] of a nuclear device [yadernoye ustroystvo] is a complex matter, it takes a long time. As a rule, it takes seven to eight years from the time

the idea is conceived to the time the weapon is taken into service. In other words, all the work must be planned. But how can we talk about planning if we have no idea of what finances will be available just one year ahead?! [Voronin continues] The average age of associates in our nuclear centers is 43 years. Now we have no opportunities to recruit younger replacements. First due to the lack of clear prospects, second due to the press campaign which has been launched against the nuclear industry. This damage could become irreparable. If the people who are now working were to leave our ranks, and if no one is training the younger generation to work properly in the dangerous job that we are doing, disaster will be inevitable. After all, the design and manufacture of weapons and munitions is not taught anywhere, not in a single higher educational establishment—it is only handed down as experience at our nuclear centers. These centers were created by recruiting specialists from all the defense enterprises in the country. The best expertise of our entire industry is concentrated there. They have developed a system of designing and finishing off the "products." It is a special system without an equal anywhere else.

I have no doubt that the nuclear centers will remain in existence. And so will the weapons. The complete destruction of nuclear weapons on the planet is far into the future. Their complete unilateral destruction will not lead to anything good. If, for example, nuclear weapons are held by just one country, by just one power, there will be incomparably more misfortunes. In my view, the world today is living without major wars only because there used to be two countries with powerful nuclear weapons—the USSR and the United States.

Georgiy Ignatov, Chairman of Chelyabinsk-70 City Soviet:

We are grateful to your newspaper for publishing reports about our city. Incidentally, we call it Snezhinsk. Let me say that our city acquired this name officially literally a few days ago.

I am a candidate of technical sciences. I have spent 25 years working on the reliability and durability of nuclear weapons. For the last three years I have been working on the city soviet. Thus I am familiar with the situation in both the institute and the city. It is really grave. The institute has debts of about 4 billion. Its associates have not received their wages for two months now.

Our city has no other enterprises. Thus, the budget's main revenue comes from the institute. And since the institute is in a state of poverty, there is no money.

Public health is in a catastrophic state, with only 15 percent of its requirements being financed. I recently visited the hospital, and saw 18 people lying there after heart attacks. The most basic medicaments are lacking—there is nothing available for treatment. There is nothing available for people to eat.... Had it not been for Chelyabinsk Oblast's help, matters would have been altogether worse. Now we are facing the question

of closing down the maternity home since the necessary medicaments are lacking and the personnel's wages are nothing but a pittance—and no wages have been paid for several months.

Now about the institute. We have elaborated conversion programs, both long-term programs and programs which would bear fruit in just a year or two. A package of relevant documents has also been compiled, but they have got lost and are gathering dust somewhere in the government.

The Supreme Soviet and the government frequently raise the question: Do we really need two nuclear centers? This is a very dangerous trend. In my capacity as specialist, I can clearly say this: When competition disappears, work efficiency will decline sharply. And safety questions will not be properly resolved. Reciprocal monitoring, competition, and joint work have helped us achieve outstanding results at costs which are one-tenth and even one-hundredth of those incurred by the Americans.

We have always tried to live a normal life in our closed cities. We have aimed for the same freedoms and the same rights as everyone else in Russia. We aimed for and were given the law on closed cities. But now we have come up against negative phenomena, especially under privatization. An opportunity has been given even to foreigners to purchase real estate on our territory. And yet the State Committee for the Management of State Property keeps telling us: Rejoice, you guys, that foreigners are buying you out, you'll have money now! You get the impression that the government does not realize what is happening to Russia's nuclear centers.

Unidentified questioner: It is well known that Chelyabinsk-70, in conjunction with a series of defense industry enterprises, has developed a fiber-optic system. Our scientists have reached a level that is either superior or at least equal to world standards. All of a sudden, the communications industry is signing a contract with foreign firms for a similar communications system, even though it is much inferior to our own. Why do you not promote your developments?

Ignatov: Nobody is listening to us! Proposals along the lines of this conversion program have been with the government for a good two years now. Furthermore, we are not asking for a single dollar, we are talking in terms of our own currency. Our system is much cheaper and more effective, but preference is nonetheless given to foreign firms. You get the impression that the Ural Mountains are further away than Europe and America....

Valeriy Menshchikov, Deputy Chairman of the Supreme Soviet Committee for Questions of Ecology and the Rational Utilization of Natural Resources:

In addition to all this, the technology developed at Chelyabinsk-70 will make it possible to solve some ecological problems, since artificial quartz is made of industrial waste. This is a step toward the solution of

many ecological problems. It is incumbent upon us to support this avenue of science, since it will enable us to extricate ourselves from the blind alley.

I am familiar with this development by defense industry scientists. Together with a European Parliament delegation, I visited the Mayak Association, Zlatoust, and Miass. Specialists told us that they are ready to begin production. That was more than six months ago. Nothing has been done, and meanwhile a barrier has been erected across our specialists' path—a contract has been concluded with foreign firms. What is happening? Why are we doing nothing?

Valeriy Skripchenko, Deputy Chairman of the Supreme Soviet Commission for Budget, Planning, Taxes, and Prices:

Unfortunately, this is not an isolated case. I can cite numerous examples from our practice over the last three years. When KamAZ needed a modeling system so as to avoid having to rock a car for several years or clock up tens of thousands of kilometers, our defense industry specialists developed it quickly. After all, they are used to relying on their own skills, being accustomed to living without foreign currency. The car makers looked at the price—100,000 rubles—and said that they would take it. Then the Americans came on the scene. They asked \$1.5 million for a similar system, which was actually not as good. And what do you think, which system was bought? The American, of course! Just because functionaries were invited and traveled there on three occasions.... There is too much foreign currency here in Russia.... If only a fraction of it, one-tenth or one-fifth, were to be channeled into the defense sphere, a lot would get done better and cheaper.

Alvin Yeremin, Chairman of the Supreme Soviet Committee for Industry and Power Engineering:

I understand and share the nuclear scientists' worries. Their alarm over the future of science in general and of the nuclear centers in particular is perfectly justified. Together with a group of deputies, I had occasion to visit the nuclear centers and the producers of their output. Frankly speaking, we never imagined that the country would be brought to this state. So far the extent of conversion has been taken to 68 percent over a very brief period of time, and essentially to 100 percent in many sectors producing arms. On the whole, this is the right avenue, but there is no need to go to extremes....

I recently visited a series of enterprises manufacturing munitions. The only ones of their kind in the country, and their conversion rate is 100 percent! Now they are producing blasting charges. Essentially, this kind of conversion is totally disarming our country....

The economic reform is accompanied by colossal errors. We are incurring huge losses. Even though our president and government pronounce that the reform's impact can be felt, that a tendency toward stabilization and even toward growth is emerging, I can cite no sectors as an

example. Even the Central Statistical Administration reports and the data we are receiving testify to a state of poverty everywhere.

As a result of this policy—or of the complete absence thereof—the most modern enterprises and science have been brought to a simply catastrophic state.

Now about the continued existence of the nuclear centers. We have no doubts on this account, on the contrary, they ought to be developed since nuclear technology has dual application, including for strictly civilian purposes. The centers have brought together top-class specialists and they must be utilized for the implementation of the most complex programs. Unfortunately, we can sense the timidity of the ministry and its leadership. This is understandable, because when some department or other keeps pushing the central government, there can be only one outcome: Awkward people get sacked. This is why ministers are afraid.

[Yeremin continues] It seems to me that we must legislatively define the status of our nuclear centers. They need special attention both from the government and from the Supreme Soviet. It is obviously expedient for scientific centers like Arzamas-16 and Chelyabinsk-70 to be allocated targeted finance, in other words appropriations under separate budget headings.

A conference of leaders of defense industry enterprises was held in the Supreme Soviet recently. The progress of conversion and the preservation of high technologies were discussed. It is clear that, unless we retain our scientific cadres and give attention to science-intensive production which includes nuclear power engineering, the country will decline very rapidly.

Valeriy Skripchenko:

I am a physicist by training, and therefore I understand and am familiar with everything that has been said here. In my opinion, we have a distorted image of science. In actual fact, the military-industrial complex today is not Russia's tragedy but its pride! I believe that the disintegration of the military-industrial complex is a crime against the fatherland because all the top achievements created in the last 100 years are concentrated there. Special attention was given to this sphere even under the czar.

Why make a secret of it, the arms trade is the most lucrative source of revenue for any state. The Americans call on us to disarm, but they themselves are earning tens of billions of dollars from the arms trade, squeezing Russia out of the traditional markets.

This is not the only sphere from which they are squeezing us out. We have only a 5-percent share of the world market for civilian nuclear fuel. Just like before, the Americans do not allow us to enter this market, they do not allow us to trade, and yet Russia today has production capacities giving it the right to claim 25-30 percent of the nuclear market. This means something

like \$5 billion. This would be enough to maintain not only all our nuclear scientists but also all of Russia's science. Briefly speaking, there is no balance in questions of nuclear disarmament and civilized trade in the world market. We are being artificially "brainwashed": The military-industrial complex is a monster, they say.

The U.S. government and even the President himself are using all means to help their firms, concerns, and enterprises conquer the arms market. Suffice it to cite the example of Finland, from where our military aviation [industry] has now been squeezed out. George Bush tackled this issue personally. Yet we are obediently sailing in the wake of U.S. policy, helping them and totally disregarding the interests of our own defense industry.

Galina Zinovyeva, Specialist From the Supreme Soviet Committee for Questions of the Work of Soviets of People's deputies and the Development of Self-Government:

Our committee, jointly with representatives of administrative-territorial formations, drafted the Law on Closed Formations. Generally speaking, there was a need for this law, people were waiting for it. This law's task is to create conditions for normal life by people working and living in closed cities. Some people believe that this is a good and necessary law, others claim the opposite. It is obvious that the law already needs to be amended. But here is something that is even worse. The law is not being properly implemented. The government is delaying the implementation of even the specific instructions enshrined in the Supreme Soviet decree on bringing the law in question into force. In practical terms, not a single one of the deadlines stipulated in the decree and, of course, agreed with the government, has been met.

Aleksey Adrov, Chairman of the Supreme Soviet Commission for Transportation, Communications, Information Technology, and Space:

Today we are living in some sort of Beyond-the-Looking-Glass world. The country today finds itself in a situation without a single program for economic transformations—be it good or bad, correct or incorrect—while we are living in total uncertainty.

The government's attitude toward science was demonstrated very graphically in the budget now submitted to the Supreme Soviet. The indexation applied to science is at the lowest coefficient of 1.3, against an average indexation coefficient of 1.9. There you have the government's attitude toward science, including fundamental science. What, in my view, could be proposed in these circumstances as a constructive supplement to what has already been said? Let me cite my limited experience in the space sphere. We had no intention of waiting but submitted our concept of Russia's space activities and our priorities. It was adopted by the Supreme Soviet. In my view, there is no point in waiting for the government to propose something. This could stretch into infinity,

until the total collapse. Therefore, nuclear center specialists, together with the relevant specialized committees and commissions, must compile their own proposals. First, a concept of state policy in the nuclear arms sphere. Let it be just a rough concept. We will submit it to the government. We will coordinate it with the government, the Ministry of Defense, and the Ministry of Atomic Energy in the first place. If we have some working material on this concept, we will distribute it further, we will coordinate it with everyone, and it will become a working document. Second. In addition to this concept, we need a specific program. People here spoke about what needs to be included in existing programs. Yes, certainly, it is possible and necessary to include items in existing programs. But it is necessary to elaborate your own program, based on everything that was said here today, and to have this program entered under a separate heading in the budget. [Adrov ends] The conversation between nuclear scientists and parliamentarians lasted for more than two hours. Naturally, they discussed not only "atomic" problems but also the state of science as a whole. It is gratifying that common points of view were elaborated and tasks were set both for the immediate and the long-term future. The result of this roundtable meeting shows that our legislators and representatives of the executive need to more frequently involve eminent scientists and specialists in their work and to consult them when elaborating various decisions and laws. After all, the nation's intellectual potential is actually concentrated in scientific centers like Arzamas-16 and Chelyabinsk-70.

Lyudmila Shikanova, general director of RIIA [precise expansion unknown] "Nekos," and Konstantin Kondyryn, leader of Arzamas-16's Public Relations Centers, took part in preparations for and the holding of the roundtable, as well as in the press conference for Russian and foreign journalists held after the meeting.

STRATEGIC ARMS REDUCTIONS

Russian Reaction to Ukrainian Efforts To Control Nuclear Weapons

Ukrainian Defense Minister's Unilateral Order Cited

LD2207092293 Moscow *ITAR-TASS World Service*
in Russian 0855 GMT 22 Jul 93

[By *ITAR-TASS* correspondent Roman Zadunayskiy]

[Text] Moscow, 22 Jul—Ukrainian Defense Minister Konstantin Morozov's order dated 3 July on the status of the "S" installations (nuclear-technical installations) located in that country shows that it has effectively declared itself a nuclear state. This was said by Russian Federation Defense Minister Pavel Grachev today at a meeting with Spanish Defense Minister Julian Garcia Vargas, who is here on an official visit.

Pavel Grachev pointed out that, by this order, General Morozov has canceled all directives of the Russian Defense Ministry on disbanding these units and has transferred them to the 43d missile army.

He expressed doubt as to whether the Ukrainian military could itself perform all the necessary organizational and technical measures associated with the functioning of "S" installations.

Further on Grachev Remarks

LD2207102993 Moscow *ITAR-TASS in English*
0949 GMT 22 Jul 93

[By *ITAR-TASS* correspondent Roman Zadunayskiy]

[Text] Moscow July 22 TASS—Ukrainian Defence minister Konstantin Morozov's order 050 dated July 3, 1993 "on the status of Objects 'S' deployed in Ukraine" testifies to the fact that Ukraine has in fact proclaimed itself a nuclear power, Russian Defence Minister Pavel Grachev told his Spanish counterpart Julian Garcia Vargas during a meeting here today.

Responding to the Spanish minister's request to brief him on the military-political situation in the Commonwealth countries, including Russia, Grachev noted that General Morozov has scrapped all the directives of the Russian defence minister concerning the nuclear technical installations in Ukraine and the disbandment of their personnel. Instead the above order transfers them to the 43rd Missile Army.

Morozov ordered new supplies and logistics support for these units and installations and had a new organizational and personnel structure created to implement a series of measures connected with the storage of nuclear-missile systems.

The preamble to the Ukrainian minister's order says it was prompted by the aggravated situation around the storage of the nuclear weapons in the republic. Morozov referred to efforts of the Russian military to restore order in these units and at the installations as "Russian pressure aimed at forcing Ukraine to recognise strategic nuclear forces in Ukraine as part of Russia's property," Grachev said.

Grachev said he doubted that the Ukrainian military would be able to carry out all the necessary organizational and technical measures connected with Objects "S."

The minister said questions relating to the status of nuclear weapons in Kazakhstan and Belarus are now being handled.

Moscow Concerned About Ukraine's Nuclear Ambitions**Foreign Ministry Statement 16 July***OW1607151393 Moscow INTERFAX in English
1453 GMT 16 Jul 93*

[Report by diplomatic correspondents Andrey Borodin, Igor Porshnev, and Dimitriy Voskoboynikov; from the "Diplomatic Panorama" feature—following item transmitted via KYODO]

[Text] "On behalf of the Russian leadership, the Foreign Ministry of the Russian Federation states that Russia threatens nobody and that all it calls on Ukraine to do is to live in friendship and maintain good-neighborly relations [with Russia]. We reaffirm all our commitments to Ukraine," Sergey Yastrzhembskiy, director of the Foreign Ministry Information and Press Department, said at a news briefing in Moscow on Friday [16 July].

He said alarming news had come from Kiev: the Ukrainian parliament had proclaimed Ukraine the owner of the nuclear weapons stationed on its territory, measures being taken to take control of them.

"Where is this policy leading to? What is it aimed at? Maybe somebody threatens Ukraine, and it is getting ready for a nuclear war?" said Yastrzhembskiy.

"Isn't it clear that making Ukraine a nuclear power would be a Pandora's box, that it would give green light to the emergence of other nuclear states and would thereby put an end to the practice of nonproliferation of nuclear weapons, that it would mean saying no to nuclear disarmament?" he continued. "How many Chernobyls would that have in store? What would be the price of somebody's megalomania for Ukraine and the rest of the world? Is that what would ensure the security of Ukraine? And is that what ordinary people want? Are the extremists aware of what their attempts to set our countries against each other may lead to? And would that affect our two countries alone?" It is up to Ukraine to make the final decision, Yastrzhembskiy said, "but we want everybody to know":

"that Russia is prepared to provide Ukraine with guarantees of its security,"

"that Russia is prepared to ensure that the temporary presence of its nuclear weapons on Ukrainian territory does not harm the environment,"

"that Russia is prepared to help Ukraine destroy those nuclear weapons, thus helping it keep the promise made by its leaders in Lisbon and thereby make some political capital," he said, reaffirming that Russia was ready to immediately reach all necessary agreements.

'Pandora's Box'*LD1607131393 Moscow ITAR-TASS World Service
in Russian 1212 GMT 16 Jul 93*

[By ITAR-TASS diplomatic correspondents Sergey Postanogov and Sergey Staroselskiy]

[Text] Moscow, 16 Jul—If Ukraine becomes a nuclear power this will be equivalent to "opening Pandora's box and giving the go-ahead for other nuclear states to spring up, thus putting an end to the regime of nuclear non-proliferation." This is the comment made at a briefing today by Sergey Yastrzhembskiy, director of the Russian Foreign Ministry's Department of Information and the Press, about the decision of the Ukrainian Parliament to proclaim Ukraine the owner of nuclear weapons.

The Foreign Ministry spokesman said that Ukraine itself would make the final decisions on this matter, but stressed that Russia is not threatening anyone and is making only one appeal to Ukraine—to live in friendship and good-neighborliness. Russia, Sergey Yastrzhembskiy continued, is ready to give Ukraine guarantees of its security, to ensure ecological safety linked with the temporary location of nuclear weapons on the territory of Ukraine, and is ready to help to eliminate the nuclear weapons and to conclude all the talks necessary for this.

Ukraine Attempts To Dismantle Nuclear Weapons It 'Owns'**Missile Base Officials Say Warheads Safe***AU2007101893 Kiev URYADOVYY KURYER
in Ukrainian 15 Jul 93 p 2*

[Mykhaylo Soroka report: "Why Did the President Visit the Missile Base?"]

[Text] Who can doubt that the Ukrainian president, who is also head of the Defense Council and commander in chief of our state's Armed Forces, possesses the necessary information on questions of Ukraine's defense capability? Including, of course, information on the strategic nuclear weapons located on Ukrainian soil. However, people say very much to the point: It is better to see once than to hear one hundred times. That is why Leonid Kravchuk's decision to visit one of the missile bases and to assess on the spot the combat readiness of the missilemen and the conditions of their service seems to be perfectly logical. All the more so since the strategic military units stationed in Ukraine are at the focus of attention of politicians, diplomats, and the world press.

As already reported, in particular in the pages of URYADOVYY KURYER, last Friday [9 July] the Ukrainian president visited one of the missile regiments. He attentively examined a missile with a nuclear warhead, went down to the underground center for controlling the complex, and had a long conversation with commanders of missile units and with officers and soldiers on duty

near the missiles. What was the subject of the conversations during these meetings? Practically all questions raised by the missilemen dealt with their material situation, conditions of the remuneration for their work, travel to other CIS states, and prospects for taking the missiles off combat status and dismantling them. However, nobody said that anything was wrong with the maintenance of the nuclear explosives or that the radioactive background allegedly constituted about 3,000 milliroentgen at the surface of some of them. It is precisely this point and this figure which were quoted in the short article "Why Did the President and the Minister of Defense Fly to Vinnytsya and Khmelnytsky After All?" published by KIYEVSKIYE VEDOMOSTI in its 10 July 1993 issue. The newspaper, quoting an officer who called the editorial board, presented himself as a specialist in nuclear missile weapons, and asked not to be named, asserted that the true goal of the trip by the president and minister of defense was their concern about the state of the nuclear explosives. The thing is, said the article, that the life of the hydrogen absorbers that cover the main parts of the missiles has allegedly expired and that they need to be immediately replaced. Such "casings" are allegedly available in storehouses belonging to Russia that are situated in one of Ukraine's eastern oblasts. However, the Russian command refuses to supply them to Khmelnytsky facilities. Can you imagine what a hazard this may involve? This means a hundred Chernobyls, asserted the anonymous officer in the telephone conversation.

Are there not enough worries, shortcomings, and fears in our life, to have yet another scarecrow added to the list? The KIYEVSKIYE VEDOMOSTI issue with the aforementioned article was published the day after the president's trip. For that reason, we journalists who took part in it could not, directly at the missile base, interview those people who know about the actual situation better than anybody else, on the allegations dealt with in the publication. We may only assert that our collocutors, in particular commander of the rocket army Volodymyr Mykhtyuk and the army chief engineer Viktor Bakhayev, did not express any anxiety about the state of the nuclear charges or their hazard to maintenance personnel or the environment. Both the missile regiments and the army as a whole are generally fulfilling their duties properly.

How does the problem of the nuclear weapons safety look on the scale of the whole of Ukraine? The URYADOVYY KURYER editorial board turned with this question to Lieutenant General Oleksiy Leontiyovych Kryzhko, chief of the center for administrative control of Ukraine's strategic nuclear troops. There is, perhaps, no need to prove, he said, that nuclear charges are a serious thing and that they need constant maintenance that involves many procedures and components, including replacement of certain units and parts. Speaking about supplies that are necessary for the maintenance of the warheads, indeed, there are problems there: There are attempts to put us in a situation in which we would be compelled to give up our nuclear

warheads. Does this create a danger? No, it does not, because here our missilemen's high professionalism comes into effect. They are capable of preventing any emergency situation. If things come to their worst, the specialists will remove the charge from the missile and take it to a special storage site or to the manufacturing plant. In other words, we are in full control of the situation and know everything about the warheads on the territory of Ukraine.

I want to stress that no deviations from admissible radiation norms could be detected at combat positions, or, as they say, the situation is normal. As concerns the storage sites, special conditions for storage and access are observed there, and these conditions are also under strict control.

The aforementioned article, continued O.L. Kryzhko, mentions protective "casings." This points to the fact that the anonymous officer is not familiar with this problem in depth. Had he been one of our people, he would not have touched upon it. It follows from this that he is not one of those who are well informed about our specifics and does not know the actual situation. We have resolved the problem of the complex absorbers of hydrogen (incidentally, not only of hydrogen, but also of some other substances).

I am far from being inclined, Oleksiy Leontiyovych concluded, to idealize the situation regarding the nuclear missiles. There certainly are problems there. Not only are the Ukrainian president, government, and the Ministry of Defense well aware of them, but they also are working on resolving them. The Ukrainian parliament is studying these problems in detail. Drafts of corresponding agreements with Russia have been prepared. However, to say that the warheads threaten a hundred Chernobyls means to stir up passions. Whoever says this counts upon naive people who are far from our sphere. A legitimate question arises: "Who gains from this?"

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IZVESTIYA Reports Missiles Off Alert Status

*PM1507150993 Moscow IZVESTIYA in Russian
16 Jul 93 First Edition p 1*

[Viktor Litovkin report: "Strategic Missiles Start Leaving Ukraine. Warheads Remaining Behind for the Moment"]

[Text] IZVESTIYA has learned that the first of the five strategic missile regiments stationed in Pervomaysk, Nikolayev Oblast, in Ukraine began being stood down from combat alert 15 July. We reported the agreement to this effect between the Russian and Ukrainian Governments in issue No. 119 of 29 June.

The regiment had 10 RS-18 (known under the NATO classification system as SS-19 "light" ICBM's) on combat alert. Each had a launch weight of 105.6 tonnes and a throw weight of 4.35 tonnes. The missile nose cone contained six nuclear warheads. The missiles were manufactured at Moscow's Khrunichev plant and had come to the end of their warranty and service life on combat duty. They could not have been kept in service, specialists say, since it would have meant incurring a great deal of material expenditure and a major safety risk.

The missile bodies are now being separated from the nose cones (which will remain in Ukraine for the time being until the fate of nuclear weapons in the republic is finally resolved), their mission programming is being downloaded and their fuel components removed (they carry around 90 tonnes of fuel, including the highly toxic and explosive heptyl, which will be remaining in Ukraine, incidentally). The "units" will then be removed from their silos and dispatched to an elimination base at the settlement of Pibanshur in Udmurtia. But even there, specialists say, the process of dismantling the missiles will be slow and difficult.

The missiles' fuel tanks will be "steamed out" [proparivat] over 10 days using a special compound in a closed, environmentally friendly process. It is very expensive but will ensure that there will be no explosions—as was the case with the medium-range missiles—and that nothing will enter the atmosphere or the soil.

All this work, I was told at the Strategic Rocket Forces headquarters, will be done only by authorized specialists following a technological process that has been developed and verified over the course of years. These will include rocket forces officers as well as engineers and designers from the Russian and Ukrainian enterprises (more than 60 of them) which cooperated on the development of the SS-19 and are responsible for each part of the missile.

The entire process of standing down the 10 strategic missiles, sending them to Russia, and dismantling them will be relatively protracted—taking until 10 September. And although, as people say, one swallow does not make a summer, things are now moving. Russia and Ukraine, and their politicians—despite the many difficulties in relations between the two fraternal countries—have finally realized the threat posed to their own nuclear safety by obsolete strategic missiles that have outlived their service life.

Incidentally, this is something that Ukrainian President Leonid Kravchuk—who visited 43d Strategic Missile Army installations in Vynnytsya and Khmelnytsky the other day, went down into the missile silos, and met with the officers on combat duty—has personally seen for himself.

Let us hope that the 166 strategic missiles left in Ukraine after the removal of the first 10 will also cease to pose any threat in due course.

Ukraine Radio Reports Russian Initiative

*LD1807173393 Kiev Radio Ukraine World Service
in Ukrainian 1600 GMT 18 Jul 93*

[Text] Radio Ukraine World Service has been informed that the Russian Government came out with an initiative with relation to the so-called "S" objects [as heard] deployed in Ukraine. It concerns nuclear engineering units dealing with the maintenance of nuclear warheads. They also provide special preventive maintenance of this

type of weapons. According to the draft agreement, all formations deployed on the Ukrainian territory will be subordinated to the Russian Ministry of Defense until the complete elimination of nuclear warheads. The Russian side also undertakes to ensure scientific and technical provisions for the use of these components during this period. At the same time, safeguards for their security must be provided. Ukraine's official circles have made no statements yet on their attitude to the draft.

Kiev Initially Denies Russian Media Reports

*LD2007044393 Moscow Mayak Radio Network
in Russian 0400 GMT 20 Jul 93*

[Text] Kiev has denied a report by Ostankino television's "Itogi" program that 10 nuclear missiles have been taken off alert in the Ukraine. Incidentally, not just "Itogi" reported this. So did IZVESTIYA and also Mayak, citing IZVESTIYA.

According to a new report, the warheads remain in the republic. A member of the Presidium of the Ukrainian Supreme Soviet, Vladimir (?Yavorezhskiy), told Ekspress-Khronika that he knows of no such thing. Missiles can only be taken off alert after Ukraine has ratified the START I treaty, he said.

(?Yavorezhskiy) stressed that the chairman of the Chernobyl disaster commission, Ukrainian President Kravchuk, can decide to ratify the treaty only with parliament's consent.

Kiev Confirms 12 Nuclear Missiles Taken Off Alert

*LD2107083093 Kiev UNIAK in Ukrainian
0700 GMT 21 Jul 93*

[Text] Kiev, 20 Jul—The "Itogi" program reported the day before yesterday that 10 nuclear missiles had been taken off alert in Ukraine. This report came from REUTERS. A UNIAK correspondent contacted Vasyl Kryuchkov, the chairman of the subcommission for the military-industrial complex and conversion at the Supreme Council commission for defense and state security. He said that 12, and not 10, missiles have been taken off alert for preventive maintenance following the schedule approved by the Defense Ministry at the beginning of the year. All preventive maintenance is being carried out by Ukrainian experts, which has never happened before. The Supreme Council will decide whether to put these missiles back on alert or not. Mr. Kryuchkov says the situation is under control.

Russian Foreign Ministry Responds

*LD2407112793 Moscow ITAR-TASS in English
1122 GMT 24 Jul 93*

[By ITAR-TASS]

[Text] Moscow July 24 TASS—The Russian Foreign Ministry has circulated the following statement:

"Disquieting reports continue reaching here from Kiev. After the Ukrainian Parliament virtually proclaimed Ukraine to be the holder of nuclear weapons, measures are being taken to bring the weapons under national physical control..."

"As far as Russia is concerned, the Ministry of Foreign Affairs is stating on behalf of the Russian Federation's leadership that Russia does not threaten anyone and that our country issues only one call to Ukraine—to live in friendship and goodneighbourly relations. We reaffirm all obligations existing between our two countries."

"Is not it clear that to make Ukraine a nuclear power is tantamount to giving the green light to the emergence of other nuclear states, thereby putting an end to the nuclear non-proliferation regime and saying 'no' to nuclear disarmament?... What will be the price, for both Ukraine and the world, of someone's ambition to exalt oneself resultant of possession nuclear munitions?"

"It is up to Ukraine to take a final decision," the statement emphasises. "but we want everyone to know the following:

- Russia is prepared to give Ukraine guarantees for its security,
- Russia will ensure ecological security connected with the temporary keeping of nuclear weapons on Ukraine's territory,
- Russia will help Ukraine eliminate nuclear weapons as Ukrainian leaders themselves pledged in Lisbon to do and receive all peace dividends from that. With this end in view, we are ready immediately to finalize all the necessary talks," the statement said.

Dismantled Missiles Remain in Ukraine

*WS2707092793 Kiev UNIAN in Ukrainian
0450 GMT 27 Jul 93*

[Text] Kiev— The Russian "Ostankino" television company reported that following the dismantling of 10 ballistic intercontinental RS-18 missiles conducted in the vicinity of Khmelnytsky on 15 June, the missiles' nuclear warheads remained in Ukraine while the carriers were transported to Russia. A UNIAN correspondent was told in the Administration of Strategic Forces at the General Staff of the Ukrainian Armed Forces that the dismantling of the 10 missiles did take place, but their carriers were still in the silos. The reason for that is lack of consensus between the Russian and Ukrainian Governments over material and financial compensation for the transferred property.

Ukrainian Participation in START I Considered**Foreign Minister Interviewed**

93WC0090A Moscow *NOVOYE VREMYA* in Russian
No 26, Jun 93 (signed to press 22 Jun 93) p 11

[Interview with Anatoliy Zlenko, Ukrainian minister of foreign affairs, by Nikolay Seregin; place and date not given: "Text of Treaty Is Too Complicated for Parliament—This Is How Ukrainian Minister of Foreign Affairs Anatoliy Zlenko Explains Why Kiev Does Not Want To Part With Nuclear Missiles"]

[Text] The decision of the Ukrainian Supreme Soviet to put off ratification of the Strategic Arms Reduction Treaty (START I) and recent statements of Ukrainian officials, including Prime Minister Kuchma, on the possibility of continuing the country's nuclear status, are frightening European politicians.

As before, there are 176 intercontinental missiles and 41 strategic bombers in Ukraine, and the nuclear arsenal, all in all, consists of 1,568 warheads.

After becoming disillusioned over the possibility of acquiring large financial assistance from the West and sensing the Russian side's firmness on the price policy for oil, gas, and other types of raw materials, Ukrainian politicians realized that they had only one trump card left in their hands—nuclear weapons.

Ukrainian Minister of Foreign Affairs Anatoliy Zlenko gave an interview to *NOVOYE VREMYA*.

NOVOYE VREMYA: It is said that Ukraine is artificially dragging out ratification of the START I treaty in order to receive some kind of advantages from the West. Is this so?

Zlenko: This is a very biased question. We have no intention of receiving any kind of advantages from the West.

We reject any pressure. Our position on ratification of the START I treaty must be understood.

NOVOYE VREMYA: Ukraine signed the START I treaty, but it has not ratified it. Ukraine has officially declared its intention to join the Treaty on Nonproliferation of Nuclear Weapons [NPT] as a state with a nonnuclear status, but for the present it is in no hurry to implement it.

Zlenko: The NPT is a very complicated document. The parliament of Ukraine has not yet had occasion to work with such a complicated document. And it was decided in parliament to study it properly. The first round of hearings is over. Parliament gave recommendations to commissions to prepare decisions, but at the same time three questions must be resolved:

- guarantees of our national security;
- economic assistance for Ukraine;

—our relations with Russia, including concerning remuneration for fuel for nuclear electric power stations. Russia is demanding payment in hard currency.

This is not a change in policy. We continue to come out for nonnuclear status, but at the same time we cannot fail to take our national interests into account.

NOVOYE VREMYA: Russian Deputy Prime Minister Aleksandr Shokhin in an interview with *NOVOYE VREMYA* said that Russia even now would want to sell oil to the CIS countries at world prices. Is Ukraine ready for this?

Zlenko: We are disappointed in the fact that Russia has raised the price for fuel by 170 times in less than a year. Enormous difficulties have arisen for the economy. On 1 April, Russia introduced world prices for energy resources. Shokhin was on a visit to Ukraine, but he did not sign agreements that could resolve any, I emphasize, any questions on economic cooperation between our two countries.

NOVOYE VREMYA: The Russian deputy prime minister believes that the CIS republics could take loans and credits to cover expenditures for the import of raw materials from Russia at world prices.

Zlenko: I must say that it will be very difficult for us to pay world prices for energy sources. And I would like to caution against the great optimism of those who are planning that everyone will pay according to world prices. Then, it will make no sense for us to buy this oil. For example, why should Uzbekistan buy oil in Russia? After all, it can buy it at this very same price in Kazakhstan or in Turkmenia—this is closer.

NOVOYE VREMYA: Then how do you propose to make payment? With reciprocal deliveries of commodities?

Zlenko: Of course. Take, for example, pipes that are used for oil pipelines, and take agricultural products and chemical commodities.

NOVOYE VREMYA: This means that in your opinion compromise is possible on this question?

Zlenko: Why not? We have ships standing in the Black Sea. For example, they can be sold at any moment. It is also possible to find other forms of payment. It is necessary to work for the common interests. You have to live, and we have to live.

Representatives of the European Community declare that the treaty on partnership and cooperation with Ukraine is not directly linked with the "nuclear question," but that they will not be able to sign it unless a solution is found.

On its part, Ukraine does not officially link the "nuclear question" with the receipt of economic advantages, and

at the same time it is simply trying to resolve its own problems, including its economic relations with Russia.

But Russia wants to receive payment in world prices for raw materials it exports, regardless of whether they are exported to near or distant foreign lands. And, judging by everything, also to pull missiles out of Ukraine without any kind of "parallel" agreements.

The practical Americans understood these logical riddles quicker than anyone else. Secretary of Defense Les Aspin brought a specific plan to Kiev, which, perhaps, will also lead to a final outcome. It envisions:

- the dismantling of missiles and the storage of warheads in Ukraine for a certain period of time;
- the gradual withdrawal of warheads to Russia;
- the sale of the uranium from the missile warheads to the United States.

It cannot be ruled out that, "in parallel," Ukraine can be granted some kinds of loans and credits.

The Ukrainian parliament has proposed that it return to an examination of the START I treaty no sooner than autumn. The internal political crisis in Ukraine can wreck these plans.

Kravchuk Reiterates Intention To Ratify START

AU1607143493 Kiev DEMOKRATYCHNA UKRAYINA in Ukrainian 13 Jul 93 p 1

[Report by Oleksandr Pobihay, DEMOKRATYCHNA UKRAYINA special correspondent: "Missiles and Missilemen"]

[Text] For the first time in all the years of its existence a journalists' "assault force" landed on the missile base. I will not say that the missilemen were particularly happy about it, but they scrupulously adhered to the protocol. One could clearly feel, behind this restraint, their concern about the future and a certain dissatisfaction with the current developments.

The ceremony of the meeting with the president also proceeded without the fanfare usually reserved for this ritual. Commander of the Rocket Troops Lieutenant General V. Mykhtyuk made a brief report on the state of affairs and on the problems that emerge in connection with Ukraine's declared readiness to dismantle its missile potential.

We became convinced that this question was a complicated one when we familiarized ourselves with the equipment of the missile base. It accommodates 90 out of 176 strategic launchers deployed in Ukraine. Everyone of us read much about the equipment and combat potential of these missiles. However, what we saw surpassed our most fantastic notions. It will suffice to say that the command post of that base is a 12-story building. However, it does not reach high into the sky, but is completely concealed underground.

We were not allowed to visit the command post center. This privilege was only granted to the president and defense minister K. Morozov. It was explained to us that, although almost everything about this base is known abroad, there still are things that constitute a secret.

Nor were we lucky enough to visit the silo's instrument section where the RS-18 missile weighing more than 100 tonnes "rests in peace." However, even what we managed to see was sufficient for us to realize that it is a complicated matter to dismantle rocket launchers and risky to boot. Keeping them in "working condition" is not easy either. It turns out that 49 of 64 enterprises and organizations that service these launchers, are located outside of Ukraine. However, the dependence here is reciprocal. The missile bases situated in other CIS countries rely largely on the support of Ukrainian enterprises. Consequently, nobody can unilaterally resolve problems that may arise. Interaction, mutual responsibility, and, of course, mutual financial settlements are necessary.

The missile men themselves probably understand this better than anyone else. Nobody would want to be in their place right now. The work to which they have dedicated their lives has turned out to be futile. It is also painful for them to think that the "property," they are leaving behind may not be used properly. These doubts are not without foundation. The army commander showed the president photographs of one of the best equipped missile bases in Zhytomyr Oblast, photographs showing its ruins....

All of these problems—the employment of the missilemen and the efficient utilization of their bases—should have been resolved by now.

"I hope that we will demonstrate enough responsibility and adopt a sensible decision—to ratify START-I and join the Nuclear Nonproliferation Treaty," declared L. Kravchuk.

"At the same time," he continued, "the problem of taking nuclear launchers off combat alert duty must be resolved in a comprehensive way. First of all, it is necessary to conclude an agreement with the Russian Federation so that Ukraine's losses may be compensated. We must also be sure that nobody will make use of these deadly weapons anywhere. Ukraine has the right to its own security guarantees."

Adamishin Calls on Ukraine To Ratify

LD2307180293 Moscow ITAR-TASS in English 1726 GMT 23 Jul 93

[By ITAR-TASS diplomatic correspondent Aleksandr Krylovich]

[Text] Moscow July 23 TASS—Let us hope that Ukraine will follow the example of Belarus and fulfil international obligations it assumed, by ratifying the START I treaty and the Lisbon Protocol, and joining the Nuclear

Non-Proliferation Treaty, Anatoliy Adamishin, first deputy foreign minister of Russia said on Friday in reply to journalists' questions.

The Russian diplomat spoke after a ceremony of handing over a document on the accedence of the Republic of Belarus to the Nuclear Non-Proliferation Treaty to the Russian Government for keeping. Now the most important thing is to see what real steps Ukraine will take in this direction, the first deputy foreign minister stressed.

"We are trying to work patiently and consistently with our Ukrainian colleagues," Anatoliy Adamishin noted. He believes that Russia clearly stated that it is prepared to give Ukraine the necessary guarantees of its security, guarantee ecological security of those weapons which are located on its territory, and ready to render assistance in dismantling and transporting these weapons from its territory.

According to the Russian diplomat, Ukraine's actions in this direction contain "both alarming and positive symptoms." He referred to the resolution adopted by the Supreme Soviet of Ukraine saying that Ukraine announces itself the owner of those nuclear weapons which are now located on its territory. "This cannot be accepted with satisfaction by Russia," Anatoliy Adamishin emphasised.

Touching on the position of Kazakhstan on this issue, the first deputy foreign minister of Russia expressed hope that Kazakhstan, in the same way as Belarus, will make a final step and join the Nuclear Non-Proliferation Treaty. Thus "Kazakhstan will bring its position to a logical end," the Russian diplomat pointed out.

SPACE ISSUES

Russian-French Space Missions Considered

Current Cooperative Effort Nearing End

PM2107103993 Moscow Ostankino Television First Channel Network in Russian 1700 GMT 19 Jul 93

[From the "Novosti" newscast: Video report by Petr Orlov, identified by caption]

[Text] [Orlov] [Video opens with shot of Mir crew inside space station] The Russian-French expedition on the Mir space station is nearing its end. Calmly, and out of sight of the television cameras, Gennadiy Manakov and Aleksandr Poleshchuk are getting ready to return to Earth after six months in orbit. Meanwhile, inside the maze of the three modules, Vasiliy Tsibliyev and

Aleksandr Serebrov prepare to take over from them for the next six months. This task is important, but tedious. And it seems that Jean-Pierre Haignere is the only one of the five having any fun, posing on the treadmill and testing microacceleration on the station with the aid of a small rubber hammer of the kind which might be used to mend an old car back home.

And the space station itself ages just that bit more with every cosmonaut's movement, every engine ignition. Just how long this can continue without endangering the crew is the central question of all recent expeditions, and all future expeditions. Agreements on the latter have already been concluded with the European Space Agency and NASA. In the absence of official comment from Russia, it can be assumed that the drift away from India and toward the United States can be attributed to the fact that the Mir space station is still operational and capable of bringing in a certain amount of hard cash—which, incidentally, will be poor compensation for the moral damage caused by the loss of our longstanding Eastern partner in space exploration. [Video shows crew inside space station, various shots of interiors of different modules, shots of external view of space station in orbit, documents being signed by unidentified officials]

Cosmonauts Report Success

LD2407134493 Moscow ITAR-TASS in English
1339 GMT 24 Jul 93

[By ITAR-TASS correspondent Anna Bakina]

[Text] Zvyozdnyi Gorodok July 24 TASS—"Our space crew have returned to Earth with a sense of fulfilled duty," Gennadiy Manakov, commander of the 13th main space expedition, told a press conference at the Zvyozdnyi Gorodok (Star City) on Saturday.

The programme lasted 22 days. The Soyuz TM-17 spaceship was launched on July 1 with cosmonauts Vasiliy Tsibliyev, Aleksandr Serebrov and French citizen Jean-Pierre Haignere on board. Following the docking with the orbital station Mir, the arrivals began to work jointly with cosmonauts Gennadiy Manakov and Aleksandr Poleshchuk, the crew of the 13th main expedition.

Cosmonauts Manakov, Poleshchuk and Haignere returned to Earth on July 22 while Serebrov and Tsibliyev remain in orbit to carry on space research.

Several types of medical, technical and technological experiments have been carried out under the Altair project. In response to a question from an ITAR-TASS correspondent, French cosmonaut Jean-Pierre Haignere said "the purpose of medical experiments was to further and specify the earlier achieved results." The cosmonauts pointed out that space walks are the most difficult aspect of the space flight.

Future Cooperation

PM2307085593 Moscow KRASNAYA ZVEZDA
in Russian 22 Jul 93 p 3

[Mikhail Rebrov report: "Russian Wings of 'Hermes.' Cooperating With Russia in Space Is Prestigious and Profitable"]

[Excerpts] It has become a good old tradition to take national emblems on board space craft. Today there are two tricolors side by side aboard "Mir": the Russian and French state flags. The joint expedition has been at work for three weeks now, and it is too early to assess its results. But we can say something about the many years of cooperation between the two countries. [passage omitted]

So much for the past. But what about the future? Among Russia's and France's other future programs you can mention the "Interbol" program planned for this year (an exploration of the plasma surrounding the earth from the "Prognoz" satellites), the "Alisa" project (a study of the earth's cloud cover from the "Mir" space station), and the "Skarabley" project (a study of the sun's effect on the circulation of the world's atmosphere and oceans from the "Meteor" satellite)... French scientists are already building an aerostat for the Russian automatic laboratory which will be launched on its way to Mars in 1996. A joint study of the state of the ozone layer in the planet's polar regions is also planned, as well as a continuation of medical and biological research on the "Biokosmos" series of satellites. Russian scientists are assisting their French colleagues in work on creating the "Hermes" flying machine which is a space shuttle...

One more space flight (the fourth) with a Russian-French crew (the "Altair" project) began 1 July (Jean-Pierre Haignere). But the space odyssey will not end with this. Before the year 2000 three more French astronauts will make flights on Russian craft. The price of one "space ticket" for the Frenchmen will, it appears, cost the same as before—73.2 million francs (this is approximately five times cheaper than a flight on the U.S. shuttle).

What attracts the French to the Russian space programs? J.L. Lions, president of CNES [National Center for Space Studies], answered this question in the following way: "For France this kind of participation has a great significance from the scientific, technical, economic, and political points of view." For my part I would say: Cooperation with Russia in space is prestigious and profitable.

Commentary Views 'Breakthrough' at Russian-U.S. Space Talks

LD2007191193 Moscow Radio Moscow World Service
in English 1710 GMT 20 Jul 93

[Announcer-read Vladislav Kozyakov commentary]

[Excerpts] At the latest talks in Washington the general director of the Russian Space Agency, the NASA leadership and administration representatives reached agreement on expanding cooperation in outer space.

The talks can be called a breakthrough in an important sphere of partnership between the two countries. Not simply because the two sides agreed to tighten controls on the proliferation of rocket technology and to lift American sanctions against Russian space companies, sanctions imposed in connection with the Russian-Indian space bid.

The two sides also worked out a package of documents on joint efforts to explore space. The documents will be discussed, finalized and signed during the visit of the Russian Prime Minister Viktor Chernomyrdin to the United States later this month.

It must be said that the two countries are already closely cooperating in space exploration. [passage omitted]

The recent talks might elevate the interaction between the two countries to a new higher orbit, so to say. The leaders of NASA and the Russian Space Agency agreed to study such projects as joint manned flights, the joint launching of an orbital station and joint programs involving a Shuttle and the Mir station. The sides agreed that probable projects will be examined by the end of August.

There is also every sign of a breakthrough in exchanges of high technology. The United States has permitted Russia to a tender for 12 space launchings and agreed to Russia's involvement in the construction of the orbital station Freedom. The use of Russian space achievements in the station should help save \$2.5 billion.

These understandings between Moscow and Washington are not an isolated phenomenon, but an inseparable part of broad international cooperation in peaceful space exploration. In this sphere the efforts of every country are precious. No doubt both Russia and the United States are going to expand commercial relations with other countries.

Restrictions in the spreading of rocket technologies cannot stop such cooperation. For example, Russia intends to continue helping India with its program of peaceful space exploration. The Space Australia consortium is discussing plans of involving Russian equipment in launchings of satellites from an Australian cosmodrome. Moscow is ready for such commercial deals.

Russia, European Space Agency Cooperate in Hermes Development

BR2307091993 Paris REACHING FOR THE SKIES
in English Jun 93 pp 14-15

[Article by G. Valentiny and D. Isakeit: "Cooperation With Russia in the Hermes Program"]

[Text] One of the important issues of the ESA Council meetings at ministerial level in Munich in 1991 and Granada in 1992 was the adaptation of the major European space programs to the new geopolitical context. Considering the constraints imposed by reduced state budgets and in the perspective of new forms of international cooperation that so far had seemed impossible, it was natural to examine whether a broader

cooperation could reduce development risks, procurement expenditures and operational costs of space programs. Potential partners for such new forms of cooperation were identified to be the USA, Russia, and Japan.

While the Western European countries have a long-standing record of cooperation with the USA and Japan in many domains, cooperation with Russia in high-technology areas is a relatively new experience. Cooperation between scientists from both sides has always existed and the Hermes program itself, long before Munich and Granada, had established first contacts with the then Soviet Union, but in the cold war climate these contacts remained symbolic and did not result in substantial joint activities.

The ESA/USSR agreement on space cooperation signed in April 1990 marked a change. Joint working groups were established to define fields of possible concrete cooperation, one of them being manned space transportation systems. The ESA representatives to this working group were from the Hermes program.

The ESA Council at ministerial level in Munich in November 1991 resulted in a further step, since the Ministers instructed the ESA Director General to investigate cost reductions of the space infrastructure programs through cooperation. This allowed the Hermes program to award about 30 study contracts with research institutes and industrial companies in Russia. The major hurdle for cooperation was a lack of mutual knowledge of each other's space programs, organisational structures, and working methods. The 30 Hermes study contracts alleviated the problem. Since no space agency existed at that time in Russia, the working group comprised, on the Russian side, representatives from Glavkosmos and from the major Russian space research institutes and scientific-industrial organisations (so-called NPO's).

The Granada Council of November 1992 opened the door to cooperation even wider. A three-year reorientation phase was introduced into the Hermes program during which the possibilities for joint development of crew and cargo transport vehicles will be investigated in depth. For this purpose and as a first step, three joint working groups for the field of crew and cargo space transport have been created between ESA and RKA, the Russian Space Agency that had been established in the meantime by the Russian Government: the STS-1 [Space Transportation System] group to cover system aspects, STS-2 for technological aspects, STS-3 for robotic means and space suits for extra-vehicular activity (EVA). In parallel, the Columbus program also set up two working groups, SSM-1 [expansion not given] and SSM-2, to study possible joint activities in the field of space stations, and of crewed missions.

More specifically, the STS-1 group will investigate the participation of ESA, as a first step, in the modernisation of the present Russian space transport vehicles (Soyuz for crew and Progress for cargo), which Russia envisages

in the framework of the new MIR-2 space station. The group will also examine the possibilities, as a second step, for joint or complementary development and utilisation by ESA and RKA of the new crew and cargo vehicles intended to replace these modernised Soyuz and Progress vehicles around 2005. The possibility of using Ariane-5 for launching these vehicles is considered by ESA as a cornerstone for cooperative activities.

STS-2, the technology group, will investigate the possibilities for joint study and development of key technologies for the projects defined by the STS-1 group. Typical technologies are aerodynamics and thermodynamics, thermal protection, environmental control and life support, avionics, and power generation.

STS-3 is looking at the EVA Suit 2000, the concept of which has been developed over the last two years by Dornier and NPO Zvezda. The objective is now to develop jointly such a suit making use of existing industrial experience and of testing and training facilities. ERA, the External Robotic Arm, is a further subject of interest for STS-3. ERA is a derivative of the ESA Hermes Robotic Arm (HERA) study and it is intended to develop such a system, compatible with the EVA Suit 2000, and to work in conjunction with RKA and Russian industry to ensure the utilisation of ERA and of the EVA Suit 2000 on the space station MIR-2 by Russian and ESA astronauts.

In order to have a sound basis for their investigations, the three working groups will jointly propose and supervise technical studies which ESA and RKA intend to award to institutes and industrial companies on both sides. In the case of the work of the groups STS-2 and STS-3, these activities continue and complement the studies already performed or started under the contracts awarded by the Hermes program in Russia in the initial cooperation scheme prior to the establishment of the three STS working groups. The new contracts with Russia will be awarded by the Hermes program team in Toulouse as well as through West-European main contractor firms. In both cases, the payments will be performed in ECUs directly from ESA to the Russian contractors and subcontractors.

The activities of the working groups are covered by a preliminary agreement, formally reached by an exchange of letters between the ESA and RKA Directors General, for a six-month period extending to end of October 1993. During this period, the working groups will work out the technical and programmatic parts of the formal agreement between ESA and RKA on the cooperation in space transport and infrastructure systems until the year 1995. This agreement is expected to be signed this Autumn.

The selection of the space transport system concepts to be examined further will be made by the STS-1 system group around spring 1994. This selection will also orient the further work of the STS-2 technology group. The

formal decision on the cooperative development and later joint utilisation of the selected concepts is expected to be made in 1995.

Future of Plesetsk Space-Launch Facility Pondered

93WC0091A Moscow ROSSIYA in Russian
No 29, 14-20 Jul 93 (Signed to press 13 Jul 93) p 9

[Article by Galina Mashtakova under "Shield and Sword of the State" rubric: "Space Knights of Russia"]

[Text] The lads of the military space forces of the USSR solemnly guarded the main military secret of the country—their involvement in the romanticism of space investigations. And to get through the difficult days and nights, they hid from the eyes and ears of their compatriots in the impenetrable taiga of Arkhangelsk. The official date of the birth of the "Plesetsk" space-launch facility is considered to be 15 June 1957. Only then it was called something else—a range for testing military missile hardware....

And while the world was enjoying the smile of Gagarin, the "secret physicists" from the military space department covered themselves in the direct sense of the word with the nuclear-missile shield of the country of the soviets and wrote their scenarios for space wars with the damned bourgeois....

With perestroyka, the military space forces became an independent branch of the Russian Armed Forces, having separated themselves from the missile forces. And they really obtained a special status with the collapse of the Soviet Union. For only they are now prepared to answer the question of whether or not Russia is to be a space power. Today the fate of Baykonur depends on the competent, intelligent, and calm politician Nursultan Nazarbayev. But what will tomorrow bring? According to the apt comment of one of the officers of the military space forces, the time may be coming when only camels will graze at our "Canaveral." And this means that the space-launch facility at the Plesetsk test range near Arkhangelsk is the only hope and support for Russian astronautics.

Where Does the Ho Chi Minh Trail Lead?

There degree or other, everyone knew about the secret of its existence. And before anyone else, of course, the potential enemies knew. At the beginning of the 1960's, they took the bearings of the second or third launch of a space vehicle. From that very moment, the secret test range in the north was under their close observation, even to the point that articles about it were published in the popular journal YUNY GEOGRAF [Young Geographer]. Shortly after that, local Arkhangelsk pathfinders made a path in the taiga that they cleverly named Ho Chi Minh. And by no means did they do that to spy or admire the "taming of fire" but with the sole more than earthly goal of supplying themselves with inexpensive delicacies and "privileged" industrial goods. That was

during the time of stagnation, when different kinds of sausage quietly lay only in towns like Zvezdnyy. And bananas cost 1 ruble 80 kopecks at Mirnyy (a closed military town at the Plesetsk test range).

Officers now remember those heavenly times with sadness in their voices, although even now they live rather well. In any event, you cannot compare the people here at Plesetsk with those unfortunate people who are being moved from far-away places abroad to an empty place or with those whom perestroyka caught by surprise in nearby foreign territory. And neither they nor their relatives want to "open" their closed city: in a local referendum, 90 percent of the population spoke out against "breaking windows" in the civilian civilization. The city lives under its own military laws and precisely this helps people to work and honestly to perform their duty to their homeland despite the general disorder.

But however they call what was spread out near Plesetsk—the "younger brother of Baykonur," "Plesetsky Space-Launch Facility," and "International Space Center Plesetsk"—it was conceived and begun as a range for the testing of combat missiles. And the first bosses here were missile people. These missiles that once stood on alert status now launch space vehicles. And in those days, when they were aimed at the United States, Nikita Sergeyevich Khrushchev pounded his shoe on the speaker's stand of the United Nations and threatened to use them.

Conversion of the 'Topol'

From a discussion with Gen A. Perminov, chief of the test range:

Question: Anatoliy Petrovich, we keep on disarming and setting up American monitoring equipment everywhere that it is possible to do so. In one sense, this is remarkable—we are ceasing to frighten the world. But is it not so that there must be reasonable limits to everything on earth? Missile forces are strategic forces. And if we think "strategically," then are we not depriving our children and grandchildren of a "shield?"

Perminov: Well, in the first place, we are setting up the equipment not only here but there as well—in accordance with the agreement, as they say. And as for missile technology, no one has taken this task away from us.... Programs are being worked out and science is thinking. And it is our "own," by the way. To be sure, no matter how many scientists are trained in our postgraduate study, Moscow takes them away from us. And that is understandable, for they are first-class specialists! Here science is applied in nature: technology and testing. There are, of course, complications with financing—there are no longer the sort of "injections" that we had before. But, as long as there are prospects of development, this means that there is stability and people can work quietly. A year or two ago, many were deserting the army, for the "market" was promising a more abundant life as civilians. We were affected by this too. We caught

the fever. The result was that the most dependable people remained. And this is important: we are forces with greater responsibility.

We would like to be hopeful at least with respect to the notorious nuclear warheads....

This year the missile people have carried out the latest conversion program: on 25 March, the intercontinental ballistic missile "Topol" launched a space vehicle for the first time. Previously after testing such missile complexes were simply blown to pieces, which did not by any means increase their efficiency. Now space vehicles will be launched on the basis of a modified "Topol." The next launch will be in the fall. Naturally it will be for national economic purposes....

In general, the rumors about the "dreadful" military function of the test range are greatly exaggerated. Yes, here there actually was a training center for the retraining of military specialists of the missile forces: officers and soldiers master new equipment and here they acquire it and set off for their place of service. This is how it is: equipment is improved and so are people. But practically every month the chief of the test range has to appear at various meetings of vigilant "servants of the people" and explain that the missiles are being tested without a "filling" and that there are no nuclear weapons at Plesetsk and never were. If the "filling" was tested, then it was at Novaya Zemlya and Semipalatinsk. Here they teach people to maintain and service that which is on alert duty in different corners of our immense Russia. Without a doubt, the inhabitants of Arkhangelsk Oblast have reason to be concerned about ecological safety. But they are clearly not looking for the source of the danger there. God knows that the local Plesetsk officers are not about to feed their own children nuts and mushrooms gathered in their spare time beyond the barbed wire. They if anyone know how edible the gifts of nature are. And the presence of grayling in the stream near the launch facility indicates something....

And with the passage of the years, the space-launch facility itself becomes quite "peaceful" [mirnyy] in accordance with the name of the town.

The Magic of Figures

From a conversation with A. Ovchinnikov, chief of the center for the testing of space vehicles:

Question: Somehow in our consciousness the mastering of space has become firmly associated with the names "Baykonur" and "Kapustin Yar." But scarcely anyone knows about the hard work that is done at Plesetsk. We carry out two-thirds of the country's space program. In America, they prepare half a year for one launch, whereas we have 50 to 60 launches a year. There were 82 launches in 1978! And practice has now shown a reliability of 0.98.

For this reason, the Americans themselves prefer to launch their space vehicles from Plesetsk—cheaply and reliably.

"0.98" means an almost 100-percent probability of success. Almost.... They showed us the monument with the eternal flame and reservedly and briefly commented: "Those are our boys." Here the questions stop at once. It is painful to remember how within just a few minutes the launch pad became a huge melted field in the midst of the taiga. After the last accident, the fourth launch complex (there are a total of nine here) was in a process of restoration for three years. And it was precisely from it, from the fourth, that in our presence the space vehicle "Resurs" (to investigate the natural resources of the earth) was put into orbit with the "Soyuz" launch vehicle. For three days, a combat crew of a unit of the military space forces prepared it for launch—from that very minute that the space vehicle joined to the launch vehicle on the erector began to move smoothly on rails from the assembly and testing building to the "iron hectare" (as the officers call the launcher). And by tradition, the unit commander walked all the way down the cross ties in front of the rocket—just to make sure. Korolev was the first to go this way before launch in the early 1960's.

There are 260 little stars at the launch facility. That is how many launches there have been. The facility is honored. In such cases, they say that it is time to retire. But...there is no replacement, just as there is no Ukrainian Soviet Socialist Republic, the homeland of the facility. Orders are now being distributed to military plants of Russia on an urgent basis. St. Petersburg promises to deliver a new launch facility by 1998. If only that were all! For three months now, Shostka has not been sending film. They are raising their prices and demanding hard currency. Because of this, they cannot launch the space vehicle "Kobalt." The officers are perplexed: "We went there and there is nothing much going on. Even the flies are buzzing around the shops. Can it really be that 'Svema' or 'Tasma' cannot make this film?" And they add: "Russia must have everything that it needs so that it does not have to get down on its knees."

Getting Off Their Knees

That is all so. It is not right for Russia to be on its knees and especially because of cable fuses and electrical equipment for ground verification of launches from Kharkov or refueling hoses from Belarus. The establishment of our own "space" infrastructure on Russian soil is an indispensable condition for us who lay claim to being a space power.

By the way, the missile people here have certainly shown themselves to be "forces with greater responsibility." Their "losses" from the disintegration of the Soviet Union are much less than those of others. It is apparent that they benefited from their specificity and secrecy. Most of the equipment was produced at Russian plants

but within a year it was possible to distribute the orders that were oriented toward nearby foreign countries to the "middle strip of Russia," figuratively speaking.

Once again you involuntarily think about the responsibility of politicians for our security. It may be that it is again necessary to show restraint and not to "slam the door," calculating a few moves in advance what is advantageous for the Fatherland.

With the background of general and local disarmament, it appears that the Plesetsk test range is not losing its importance but rather is becoming more important. It is not for nothing that the president of the country, the commander in chief of the Joint Armed Forces of the CIS, and the Minister of Defense of Russia visited here in the last year. And one of the latest launches was observed by M. Kolesnikov, chief of General Staff of the Ministry of Defense of Russia, and V. Ivanov, commander of the space forces, along with us.

To remain one of the major and leading powers, Russia needs a dependable nuclear-missile shield and prospects for the development of space research.

And in this connection, it is by no means unimportant whose hands are operating "ground" and "underground" control consoles. When he left us, Gen A. Perminov said: "I am quite confident that there will be no tragedies and no accidents in the missile forces...." One would like to believe that. And let the "probability of 0.98," as the missile people and cosmonauts say, always be confirmed with a reality of 1.0.

Russian Space Agency Chief on Commercial Satellite Launchings

LD2607165493 Moscow *ITAR-TASS World Service*
in Russian 0710 GMT 26 Jul 93

[By ITAR-TASS correspondent Anna Bakina]

[Text] Moscow, 26 Jul—The launching of commercial satellites into space is becoming more and more popular throughout the world. Not only is this a good investment but there are vast profits in it. Your ITAR-TASS correspondent asked Yuriy Koptev, director general of the Russian Space Agency (RSA), about Russia's place in the space market.

"At present supply exceeds demand by two and a half times," the RSA chief noted. "States are 'queuing up' to

have the opportunity of launching a commercial satellite. For instance, according to 1993 data, countries have had the opportunity to launch 27 satellites, but only 20 will be launched." This is connected with many reasons, one of which is the present-day duration of flights and their long-term space programs. The queue for launches now stretches up to 1995. These are preliminary plans for the time being, suggesting that there is a particular kind of competition. In this competition Russia is "favored" at best with nine European satellites and the possibility of involvement in the launching of U.S. satellites. This is out of approximately 40 "free" satellites now in the market.

The fact is that 70 percent of these space instruments are made in the United States. U.S. components are used in the remainder made by other countries. Therefore, in order to play a full-blooded part in the business of the space market, it is essential to have an export license the cost of which is expressed not in monetary value, but in the difficulty of obtaining it. The Russians themselves, Yuriy Koptev admits, are today not in a position to carry out commercial launchings independently at a current cost of \$600-700 million. There is also in existence a program of launchings of conventional Russian satellites, but in terms of money these are much less profitable.

CONVENTIONAL FORCES IN EUROPE

Belarus Seeks FRG Help With Arms Cuts

PM1507135993 Moscow *KRASNAYA ZVEZDA*
in Russian 15 Jul 93 p 1

[Pavel Chernenko report: "Belarus Asks Germany for Help in Destroying Arms"]

[Text] Minsk—According to the Treaty on Conventional Forces in Europe, Belarus must cut 2,171 tanks, 167 aircraft, 1,087 infantry fighting vehicles, and 333 armored personnel carriers. Experts calculate that this will require up to \$33 million in the very near future. Belarus is currently spending 1.6 times more on cutting combat equipment than the United States, Britain, and France together.

To ensure that the process of the destruction of combat equipment does not stop in the very near future for want of finance, Belarus has turned for help to Germany, asking it to provide highly efficient portable units for cutting up armored vehicles.

REGIONAL AFFAIRS

European-U.S. Consortium Proposes Private Space Laboratory*BR1607120293 Bonn DIE WELT in German
14 Jun 93 p 18*

[Article by Anatol Johansen: "The Way Into Space To Become Cheaper—European Companies Propose Using Private Space Laboratory"]

[Text] At the Aviation Fair in Paris at the weekend, one American and four European companies set out a joint proposal for making manned European space travel cheaper. They propose using a privately developed space laboratory.

Europe currently finds itself no longer in a position to adhere to its space travel plans. The ESA (European Space Agency) countries have so far underwritten only about 50 percent of the estimated ECU300-million requirement. Alenia Spazio of Rome, DASA-ERNO [Northern Development Ring] of Bremen, Intospace of Hannover, and Matra-Marconi of Velizy near Paris have therefore suggested using the cheaper Spacehab instead of the Spacelab. NASA [National Aeronautics and Space Administration] estimates the cost of launching the present space laboratory with an American space transporter at around \$120 million.

The Spacehab—built by the Italian firm, Alenia Spazio—is also tailor-made for American space shuttles, but is only one-quarter the size of the present laboratory, which likewise reduces the cost of its use to only one-quarter, or about \$30 million.

Spacehab is to be launched for the first time on 20 June—not on behalf of the Europeans, but for NASA, which has secured the first six missions. The small space laboratory is an industrial development, not a government project. The commercial operator is Spacelab Inc. of Arlington, Virginia, which rents Spacehab to NASA, ESA, industry, and other users.

ESA plans for European astronauts to undertake some training flights before boarding American space station Freedom at the end of the decade. This "Precursor Program" should cost around ECU300 million, and comprise four operations: a joint flight by European and American astronauts in Spacelab, two visits to the Russian Mir space station, and an unmanned EURECA [European Retrievable Carrier] research platform mission.

Space Experiments on EURECA Platform Described*BR2707145193 Noordwijk MICROGRAVITY NEWS
FROM ESA in English Jun 93 pp 17-26*

[Article by O. Minster of the ESA's European Space Research and Technology Center in Noordwijk, the Netherlands: "Microgravity, Space and Technology

Experiments Onboard EURECA"; all numbers in chemical compounds are subscript unless otherwise stated]

[Text] The European Retrievable Carrier, EURECA, has been primarily designed to enable scientists to carry out long-duration experiments under accurately controlled microgravity conditions.

The core payload of EURECA was developed by industry under ESA contracts managed by the Microgravity Division of ESTEC [European Space Research and Technology Center] and includes the following multi-user facilities:

- the Automatic Mirror Furnace (AMF),
- the Multi Furnace Assembly (MFA),
- the Solution Growth Facility (SGF),
- the Protein Crystallisation Facility (PCF),
- the Exobiology and Radiation Assembly (ERA).

In addition to the core payload, two stand-alone instruments were provided by national space agencies: the High-Precision Thermostat (HPT) from Germany and the Surface Forces and Adhesion Instrument (SFA) from Italy.

EURECA was released from the space shuttle Atlantis by ESA astronaut and mission specialist Claude Nicollier (flight STS-46) in August 1992. It then used its own propulsion system to transfer to the operational orbit at 508 km altitude. After commissioning, payload operations started and experiments were performed over the six months of the operational phase. The experimental programme with the core payload could be completed successfully by the end of February 1993 and the facilities were essentially deactivated during the subsequent dormant phase. The HPT and the SFA instruments were still operated until the orbit change manoeuvres were started for the retrieval, taking thereby maximum advantage of the microgravity environment to get valuable scientific data.

A Microgravity Measurement System including several accelerometers located at different points on the spacecraft permitted continuous monitoring of the residual accelerations. The performance of the spacecraft and its payload in terms of perturbation to the experiments were outstanding and the specifications were largely attained. The residual accelerations recorded hardly 10-6g0 [as published] over the whole frequency spectrum.

The experiments performed in the core payload benefited from the efficient support of a dedicated team located at the Microgravity User Support Centre, Cologne, (Germany). After having participated in their preparation, the team monitored the experiments during the operational phase and acted as an interface between

the investigators and ESOC [European Space Operations Center], from where the spacecraft and its payload were controlled.

The main fields of microgravity research addressed during the EURECA mission are as follows:

- mass transport by diffusion in liquids,
- crystal growth of electronic materials,
- crystal growth from low-temperature solutions,
- crystal growth of biological macromolecules,
- liquid-phase sintering of composites,
- wetting behaviour in metallic immiscible systems.

The scientific background and a short description of the experiments are given in the following, as well as some preliminary results. In most cases, however, the scientific outcome of the experiments will be known only after a thorough analysis of the samples and the data will have been performed.

Mass Transport by Diffusion in Liquids

Experimental measurements of mass transport by diffusion in liquids are extremely difficult to perform on the ground with the required accuracy due to the unavoidable contribution of buoyancy convection to the mass transport process.

Thermodiffusion, also called Soret effect, occurs in mixtures, including mixtures of isotopes, submitted to a temperature gradient. This effect leads to the segregation of the different species according to their density. The Soret coefficient, which is the ratio of the thermal to the isothermal diffusion coefficient, is defined positive if the denser component migrates towards the cold side. This effect occurs in all three states of the matter, but is obviously greatest in gases.

In the Multi-Zone Furnace of the MFA, Dr. J.P. Praizey, CEN [Nuclear Research Center] Grenoble, conducted experiments on thermodiffusion in alloys and pure metals. A shear-cell was used which accommodates four samples (two samples of Au-Sn and two samples of Sn only, for isotopic separation). After 10 days, when the steady state was reached, the shearing mechanism was activated and each sample, still in the liquid state, was divided in several sections and then solidified. The relative concentrations in each section will be measured on the ground.

A similar investigation was performed by Prof. J.C. Legros, Université Libre de Bruxelles (Belgium), with various binary organic mixtures and aqueous electrolyte solutions. The experiment is accommodated in a dedicated SGF container housing 20 tubes with a volume of less than 10 ml for 8 cm in length. In microgravity, a temperature difference of 8 degrees Celsius was imposed between the two ends of the tubes. One of the tubes filled with an aqueous solution of silver nitrate is equipped

with electrodes which allowed to follow in real time the evolution of the concentration gradient. Before the end of the microgravity period, a liquid sample of about 1 ml was isolated at both extremities of all tubes for further analysis on the ground.

The objective of the experiment performed by Dr. L. Ratke, Institute for Space Simulation, DLR [German Aerospace Research Establishment] Cologne, is to improve the understanding of interfacial phenomena in liquid alloys by studying diffusion phenomena such as Ostwald ripening in immiscible metallic liquids. The analysis of the samples will enable to determine interfacial energies and diffusion coefficients at various temperatures and for different compositions. Such data are essential for the theoretical modelling of the solidification of monotectic alloys. On EURECA, the planned temperature/time profiles were successfully achieved in three isothermal furnaces TEM01 of the MFA and nine samples of Al-Pb alloys of different compositions were processed.

Crystal Growth of Electronic Materials

Gravity has a significant influence on the quality of crystals as the fluid phase, be it liquid or gaseous, from which they are grown is the seat of buoyancy convection flows which make heat and mass transport conditions during the growth process quite complex. Convection acts at a macroscopic scale as it redistributes permanently in the fluid phase the doping species segregated at the growing interface. This leads to a continuous change of the macroscopic dopant concentration and thereby to non-uniform properties along the longitudinal axis of the crystal. At a microscopic scale, gravity-driven unsteady convection flows in the fluid provoke temperature fluctuations at the growing interface and thereby striations in the crystal.

In microgravity, heat and mass transport occur by diffusion only and can therefore be much better controlled. By comparing space and ground experiments, one can establish a clear distinction between gravity-dependent and gravity-independent inhomogeneities and defects. Moreover, experimentation under microgravity conditions is the only means of studying fundamental phenomena in crystal growth which are masked on the ground by the influence of gravity.

Growth From Metallic Solutions

Metallic solution growth of electronic materials has some major advantages over melt growth methods:

- the vapour pressure is low or negligible due to the lower growth temperature;
- lower contamination of the solution by the ampoule or the crucible material;
- the lower growth temperature reduces the deviation from stoichiometry for purely thermodynamic reasons, which result in more perfect crystals.

The AMF facility is particularly suitable for the crystal growth from metallic solutions using the Travelling Heater Method (THM). With this technique, the material is transported from a source to a seed via a metallic solvent. The solvent is placed in the growth ampoule between the source and the seed. The process consists of melting the solvent zone located at the focus of the ellipsoidal mirror of the AMF and pulling the ampoule so that the focus moves away from the seed. The shift of the temperature profile provokes the precipitation of the material on the seed and, simultaneously, the dissolution of the source into the solvent. The difference in solute concentration across the solvent provokes solute transport which, in the absence of buoyancy convection, is driven by diffusion only.

In total, 13 THM growth experiments were performed in the AMF. Six were concerned with CdTe samples in a coordinated investigation between Prof. R. Nitsche and Prof. K.W. Benz, University of Freiburg (four samples) and Dr. J.C. Launay, PRAME [Acquitaine Research Center for Materials Development in Space] Bordeaux (two samples). Prof. R. Nitsche and Prof. K.W. Benz also conducted experiments with two samples of InP and two of GaAlSb. Dr. R. Dornhaus, Battelle Institute, Frankfurt, has grown three crystals of PbSnTe and Prof. V.H. Kraemer, University of Freiburg, two crystals of the ternary sulphide with chalcopyrite structure AgGaS₂.

Crystal Growth From the Vapour Phase

Crystals can be grown from a vapour phase by physical vapour transport (PVT) or chemical vapour transport (CVT). With these techniques, material transport from the source to the seed occurs via the gas phase. On Earth, gravity-driven convection in the gas phase degrades the quality of the crystals in terms of chemical inhomogeneities and crystalline defects. Prof. R. Nitsche and Prof. K. Benz, Freiburg University, grew two crystals of CdTe and two of CdSe in the AMF. Both PVT and CVT were implemented with each material. Three vapour growth experiments were also performed by Dr. J.C. Launay, PRAME, in multi-zone furnaces of the MFA. The PVT method was applied to grow two crystals of Pb_{1-x}Sn_xTe and the CVT technique was implemented to grow a crystal of GaAs using a half sphere of monocrystalline AsGa as a seed.

Crucible Dewetting in Bridgman Growth

Semiconductor crystals grown in space in a Bridgman configuration do not always adopt the morphology of the inner wall of the crucible. Dr. T. Duffar, CEN Grenoble, proposed a model which predicts the separation of the crystal from the crucible when the crucible surface is distinctly rough and the wetting angle of the melt on the crucible material is large. In microgravity where the hydrostatic pressure is virtually eliminated and capillary forces dominate, dewetting is obviously favoured. Such a behaviour is of particular benefit as it reduces the chemical contamination by the crucible material, the thermal contact between the melt and the crucible and,

eventually, the mechanical constraints by the crucible during cooling. Both the theoretical and the practical aspects of the dewetting phenomenon will be investigated by Dr. Duffar with the two samples of GaSb and GaSb-InSb (99 percent/1 percent), which were processed in the AMF.

Crystal Growth From Low-Temperature Solutions

This technique presents the great advantage of avoiding thermal stresses in crystals during after-growth cooling. It is also the only means of crystallizing thermally unstable materials. The classical "double diffusion" technique was implemented in three growth reactors accommodated on the SGF. In each reactor, two solutions of the two chemical constituents were initially isolated and, in microgravity, allowed to diffuse into a chamber filled only with solvent. When the two diffusion fronts met, the chemical reaction led to the progressive precipitation and crystallisation of the product. With free solutions on Earth, this method is strongly disturbed by gravity, as density differences due to concentration gradients generate convection flows which perturb the concentration field. Crystalline nuclei also tend to sediment and multiple nucleation occurs so that a polycrystalline powder is obtained instead of a single crystal.

Two SGF reactors were employed by Prof. H.E. Lundager Madsen, Royal Veterinary and Agricultural University of Denmark, to grow calcium carbonate crystals and to study the formation of amorphous tricalcium phosphate under microgravity. Calcium carbonate has useful optical properties and is of interest in basic research on crystal growth in the bio-environment as large, highly perfect single crystal. Amorphous tricalcium phosphate (ACP) is a frequent precursor to crystalline calcium phosphates when precipitation occurs in an approximately neutral solution. It is formed immediately or shortly after the ion activity product of tricalcium phosphate exceeds a certain critical value which is temperature dependent. Some hours later, in the absence of stabilising substances, one can find in the precipitate crystals of different types depending on the initial concentrations, the pH and the temperature. It is generally assumed that ACP is also a precursor in the mineralisation of vertebrate hard tissue and in the formation of apatitic urinary calculi. The experiment performed in the third reactor of the SGF by Dr. M. Stocker of the Centre for Industrial Research of Oslo, Norway, aims at obtaining large single crystals of offretite.

The offretite-erionite series of zeolites are candidate catalysts for industrial processes. Zeolites were used as heterogeneous catalysts in many technical processes such as catalytic cracking and the methanol-to-gasoline process. Their importance as catalysts is mainly related to their special properties such as their cation exchangeability and their shape selectivity due to a well defined pore structure. Studies on single crystals would provide a better basis for the design of zeolites and thus result in more active and selective catalysts. On Earth however, synthetic zeolite crystals are grown in aqueous gels where

a large number of single crystals usually nucleate, thereby limiting the size of individual crystals. Large offretite crystals are expected to have grown in microgravity, and should present a reduced density of point, line, and plane defects as well as a reduced surface roughness compared with crystals produced on Earth. Such a "perfect" material would be a valuable reference substance for testing the catalytic properties of zeolites and for the design of industrially relevant catalysts.

Crystal Growth of Biological Macromolecules

Biological macromolecules play a decisive role in all vital processes. The largest group is formed by proteins. Proteins are the basis of every process that takes place in a cell and knowledge of their three-dimensional structure is the only way to understand their molecular functioning. Presently, such information is available of only a small fraction of all identified proteins. Since they have such a wide variety of functions within a cell, they are the target for most drugs. If the target protein of an active substance and the three-dimensional structure of this protein were known, it would be possible to design drugs which would be readily recognised by this macromolecule and which, therefore, would have an optimum effect. And perhaps equally important: The structural model of the protein involved can be used to judge which derivatives of a potentially active substance do not need to be tested, since they will not fit in the binding site. Time consuming and expensive synthesis work can be saved in this way. Modern drug design, therefore, requires the knowledge of protein structures.

X-ray diffraction of macromolecule crystals is the most accurate method of determining their structure. With appropriate crystal quality, the position of the atoms can be determined with an accuracy of between 0.1 and 0.2 Angstroms. Unfortunately, protein crystals do not grow to order. It is a trial and error process which is influenced by many factors. A general rule is that crystals should grow as undisturbed as possible. On Earth, the growth is disturbed by gravity-driven flows of solution around the crystal and the sedimentation of growing crystals accompanied by the formation of clusters and aggregates. A number of space experiments were already performed during Spacelab and sounding rocket flights which produced, in some instances, significantly better crystals than ever before on the ground.

The 12 chambers of the PCF on EURECA were used by five investigators to grow crystals of different proteins:

- Complexes between aminoacyl-tRNA synthetase and native tRNA or tRNA produced in vitro (Dr. R. Giege, IBMC-CNRS [Molecular and Cellular Biology Institute of the National Center for Scientific Research] Strasbourg, France)
- Lysozyme and Beta-galactosidase (Dr. W. Littke, University of Freiburg, Germany)
- Rhodopsin (Dr. W.J. de Grip, University Nijmegen, the Netherlands)

—Alpha-crustacyanin (Dr. P.F. Zagalsky, Royal Holloway College, Surrey, UK)

—Bacteriorhodopsin (Dr. G. Wagner, Justus Liebig University, Giessen, Germany)

Protein crystals were clearly visible on the video images of a number of the PCF reactors but their quality has become questionable after an unintended transient warming occurred in all 12 reactors.

Liquid-Phase Sintering of Composites

The structure and homogeneity of composites manufactured by liquid phase processing techniques can be influenced by gravity as convection and sedimentation may lead to the agglomeration or separation of the second phase inclusions. The manufacturing process of WC-Co hard metals by powder metallurgy routes includes liquid phase sintering. On Earth, when the mass fraction of Co exceeds 25 percent, the samples deform under their own weight during sintering ("jumbo foot"), or the microstructure becomes inhomogeneous. Furthermore, the WC particles are not evenly distributed and isolated from each other but rather form a skeleton. Current theory predicts that a minimum rate of contact formation between particles can be attained by decreasing their size to a point where the sedimentation effects are significantly decreased and the Brownian motion effects are not yet predominant. However, experiments carried out on the ground yielded samples with pronounced connections between the particles. Dr. W. Graf, Krupp Pulvermetall GmbH, Germany, expects to confirm the theory by observing in microgravity, i.e., in the absence of sedimentation effects, a dependency of the degree of dispersion on the particle size opposite to that observed on the ground. Nine samples of WC-Co with different particle sizes were sintered as planned over different durations in three isothermal furnaces TEM-01 of the MFA.

Wetting Behaviour of Metallic Immiscible Systems

The monotectic reaction which occurs during cooling of systems presenting a miscibility gap in the liquid phase is greatly influenced by the morphology of the interface between the two immiscible liquids as well as their behaviour at the triple junction between the two liquids and the container wall (wetting angle and spreading coefficient). Experimental studies of the influence of the container material are performed with samples where, at a temperature just above the monotectic point, a bridge of one liquid is stabilised between two ceramic plates in the second immiscible liquid phase. After quenching the sample, the liquid-liquid and solid-liquid interfaces are examined and chemical interactions and diffusion phenomena along and across the boundary layers are studied. In microgravity the central liquid bridge remains stable at higher length-to-diameter ratios than on Earth. A model was proposed to predict the ratio corresponding to the stability limit in microgravity in the case of immiscible liquid metals and one of the aims of

the experiment is to verify this model with samples of Al-In and Zn-Bi and ceramic plates made of Al_2O_3 , SiO_2 , SiC, AlN, Si_3N_4 , and vitreous carbon. In addition, even if, from a purely thermodynamic point of view, the contact angle between the phases at equilibrium does not depend on gravity, unexpected phenomena, such as creeping of liquids along ceramic walls, and variations in the spreading kinetics when capillary forces become predominant, were detected during former microgravity experiments. This experiment, performed in an isothermal furnace in the MFA, had been specially conceived with the purpose of gaining a deeper insight into such phenomena.

Adsorption Near the Critical Point

Physical adsorption of fluids at solid surfaces and in narrow pores is of importance in several fields of chemical engineering and applied technology. There is a marked difference in the adsorption behaviour at temperatures well below the gas/liquid critical point where the fluid exhibits multilayer adsorption and pore condensation near its saturation pressure, and adsorption of supercritical fluids at elevated pressures and temperatures well above the critical point. Therefore, a better understanding of the adsorption behaviour of near-critical fluids is of central importance for a unified description of their physisorption behaviour. Experimental studies of the thermophysical properties of fluids in their critical region are affected by the gravitational field and are sensitive to temperature gradients in the experimental cell. The HPT was developed to enable Prof. G.H. Findenegg, Technical University of Berlin (Germany), to study the critical adsorption of a pure fluid (sulphur hexafluoride SF_6) on an adsorbent with an atomically ordered surface (graphitized carbon). A new volumetric technique is implemented for the measurement of the surface excess amount at various temperatures along the critical isochore starting at the reference temperature (60 degrees Celsius) and approaching the critical temperature (45.55 degrees Celsius).

Measurements of the surface excess amount performed on the ground with different versions of HPT are in qualitative disagreement with theory. This can be either due to the influence of gravity or to a genuine effect not accounted for by the current theory of critical adsorption.

Results from the first flight run are unexpectedly similar to those obtained on the ground, which would indicate that the discrepancy between the theory and the experiment is not to be attributed to gravity-driven effects. Five runs were performed and a careful and complete analysis of all flight data, as well as complementary runs on the ground after the mission are still necessary before one can draw a definite conclusion.

Surface Forces and Adhesion

Surface forces and interface energies of solids depend on a number of physical and physico-chemical parameters,

such as the surface roughness and cleanliness, the temperature, and the mechanical properties of the contacting bodies, in particular their deformation properties. So far, measuring these on Earth has always been hampered by the interference of much stronger forces, mainly the weight of the bodies. The SFA instrument was conceived to enable the study of the collision dynamics of 18 types of metallic projectiles, about 4 mm in diameter and 0.3 g in mass, and with velocities from 0.1 to 2 mm/s, on metallic targets made of gold, titanium, stainless steel, or nickel. The objective was to verify theoretical predictions such as:

- no rebound of the projectile below a threshold impact velocity;
- the dependency of the restitution coefficient on the impact velocity near the threshold which relates to surface energies and adhesion;
- the variation of the contact force with contact time which depends on the characteristics of surfaces forces;

Accurate and highly reproducible data could be recorded from a few thousand collision events during the mission, and surface and adhesion effects could be clearly identified.

The ERA facility, also onboard EURECA, is taking advantage of the flight characteristics (sun pointing) to achieve long-duration exposure of biological samples to the specific environment of space.

Exobiology and Radiation

When we enquire about the principles leading to the emergence of life from inanimate matter, its evolution, and its distribution on Earth, we are still facing many unknowns. Exobiological research may add many new pieces of information to our concept of "life" by expanding research beyond the Earth, to space and planets, the comets, and the meteorites of our solar system. Such "cosmological" research calls for a multidisciplinary approach in which scientist in astrophysics, planetary research, organic chemistry, paleontology, and biology must work together.

The space environment has generally been viewed as extremely hostile to all forms of life, due to:

- the high vacuum, with pressure as low as 10^{-14} Pa;
- the solar electromagnetic radiation, extending from wavelengths; of 2×10^{-12} to 100 m
- the solar corpuscular radiation emitted in the solar wind and during the solar flares;
- the galactic cosmic radiation, consisting approximately of 86 percent protons, 12.7 percent He-ions, 1.3 percent heavy ions with charge Z greater than two, and electrons;

—the extreme temperatures determined by the deep space temperatures of 4 K and by the position of a body relative to the Sun.

While this extreme environment represents a definite barrier for the active biological growth, metabolism, and reproduction, some living organisms such as the spores of bacteria and fungi have the capacity to survive harsh conditions in a dormant mode. However, the complex action of the factors found in the space environment cannot be fully reproduced in laboratories, and all theories so far have been based on results from laboratory experiments and a few short-duration space experiments. ERA was developed to give scientists the opportunity to fly experiments in space for a relatively long period of time. The facility accommodates two sample trays, one fixed and one deployable, containing sets of passive samples. It enabled scientists to expose biological samples to the solar radiation, the space vacuum as well as the deep environment. The samples will be analysed on the ground.

Space Science—Solar Physics—Technology

The flight conditions of EURECA were particularly suitable for a number of add-on instruments for investigations in astronomy, solar physics, cosmic particles, and technology.

The Wide Angle Telescope for Cosmic Hard X-rays (WATCH) of the Danish Space Research Institute (Prof. N. Lund) monitored about 20 sources on a day-to-day basis, and five bright new sources (transient) were discovered.

The Solar Spectrum Instrument (SOSP) operated for CNRS Paris (Dr. G. Thuiller) allowed to measure the absolute spectral irradiance of the Sun between 170 and 3,200 nm and to detect its variation with the solar cycle. The Solar Constant and Variability instrument (SOVA) of the Royal Meteorological Institute of Belgium (D. Crommelynck) allowed the determination of the Solar Constant, its variability, and its spectral distribution at five different wavelengths. The Belgisch Instituut voor Ruimte Aeronomie, Brussels, (Dr. E. Arijs) measured aerosol and trace gas densities in the Earth's atmosphere with the help of the Occultation Radiometer (ORA). The instrument measured the solar radiation during sunrise and sunset to determine concentrations of ozone, nitrogen dioxide, water vapour, carbon dioxide, background and volcanic aerosols, and dust from 20 km up to 100 km altitude.

The Timeband Capture Experiment (TICCE), proposed by Dr. J.A.M. Mc Donnell, University of Kent, Canterbury, aimed at studying the population and chemical composition of particles in near-Earth space.

New technologies could be successfully tested under real conditions. The Radio Frequency Ion Thruster Assembly (RITA) developed at MBB [Messerschmitt-Boelkow-Blohm] Ottobrunn, Germany showed its ability to generate a variable thrust between 5 to 10 mN. An ESTEC team led by Mr. P. Sever tested an interorbit communication system installed on the spacecraft which was extremely helpful in receiving real-time data on the ground via Olympus, in complement to the EURECA data transmission. The Advanced Solar GaAs Array (ASGA) developed at CISE [Center of Information, Studies, and Experiments] Milano showed the excellent performances in terms of a very-high-power output and a stability to the environmental effects.

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